SEECS
SCHOOL OF ELECTRICAL ENGINEERING & COMPUTER SCIENCE, NUST

ABSTRACT BOOKLET

CLASS OF
2026

SCHOOL OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

BEE - BACHELOR OF ELECTRICAL ENGINEERING

INTRODUCTION TO SEECS

NUST-SEECS stands as a center of excellence, dedicated to advancing research and innovation in the fields of computing and electrical engineering. Our institution fosters a dynamic learning environment where students are encouraged to bridge the gap between academic theory and practical industry application. We take immense pride in our faculty and students, whose unwavering commitment ensures a spirit of distinction in every project and endeavor. By integrating professional ethics with technical mastery, we prepare our graduates to lead with integrity in the global technological landscape.

SEECS programs are globally recognized in the QS World University Rankings by Subject - **Computer Science ranks 114th globally, making it the #1 Computer Science program in Pakistan**, while **Electrical Engineering ranks 131st** and **Software Engineering ranks 132nd worldwide. Computer Science** also holds the distinction of being the **top merit program across all NUST programs,** reflecting the exceptional caliber of students it attracts.

The school remains at the forefront of national progress, cultivating the next generation of strategic thinkers and visionary engineers. Our graduates are equipped with a unique blend of technical expertise and leadership skills, making them highly sought after in the professional sector. By fostering a culture of continuous improvement and self-empowerment, SEECS continues to define the standard for engineering education in the region.

Greeting & Message from

Principal NUST-SEECS
Dr. Muhammad Ajmal Khan, SI(M)

PhD (Michigan State University, USA)

It is a pleasure to introduce to you the graduating classes of 2026 in the disciplines of Electrical Engineering, Software Engineering, and Computer Science. NUST-School of Electrical Engineering and Computer Science (SEECS) is committed to providing first-rate higher education in Pakistan. We emphasize making SEECS a center of excellence for imparting high-quality education in the areas of Electrical Engineering and Computer Science that would lead to the promotion of research and scholarly achievements at National & International levels. We foster a passion for creativity and productivity in our students through an enabling environment of state-of-the-art labs, arranging industry visits, seminars, and international conferences, etc. Besides imparting thorough professional knowledge, we also believe in instilling sound entrepreneurial, social and humanitarian values. The programs offered at SEECS include Electronics, Digital Systems, RF and Microwave, Telecommunication and Networks, Artificial Intelligence, Machine Learning, Big Data, Cyber Security, and Cloud Computing. Hands-on training in these domains augments the basic knowledge of our students, giving insights into its practical application, an essential prerequisite for potential technical leaders of the 21st century. The projects showcased in the Open House demonstrate the skill set of our graduating students, and the highly interactive sessions with the industrial professionals provide them a platform for networking. Another aim of holding this event is to address the dire need for industry-academia partnerships in Pakistan. Through Open House, the industry can witness the outstanding research of various disciplines that are being offered at NUST-SEECS. At the same time, the industry feedback helps us update our curriculum according to the contemporary market trends. Henceforth, I take immense delight in presenting the batch of 2026 as the proud product of SEECS and wish them success as they go forward in their respective fields, with all the best for their journey ahead.

OVERVIEW OF

OPEN HOUSE

NUST SEECS organizes its annual open house to showcase the skills of its graduating students. The idea is to provide a platform where our students and industry representatives can mingle and have informal or formal discussions. The students showcase their final year projects which represent their skill set and enable potential employers to identify any matching requirements. The projects are presented by students from:

Department of Electrical and Computer Engineering (ECE)

The Department of Electrical and Computer Engineering has divided its projects into five knowledge areas: Power Electronics and Control, Digital Systems and Signal Processing, Integrated Circuits and Systems, RF & Microwave, and Smart Telecommunications and Systems. There are a total of 70 projects presented by 168 students, divided into the above mentioned knowledge groups. Most of the projects are aimed at providing technology-based solutions for social problems.

At NUST SEECS, we take pride in molding our bright entrants into well trained and appropriately groomed professionals in Computer Science, Software Engineering & Electrical Engineering. Our graduates are actively sought by the industry and our Alumni are occupying promising positions in some of the most prestigious industrial and business houses, both in public and private sectors. We hope you enjoy the hard work of our students and find the right candidate or the next big idea for your company.

Contents

01 Knowledge Group

Artificial Intelligence & Autonomous Systems

Programmable Modular Robot with Line Following and Basic Sensing

Group Members: Mohammad Ahsan | Rehan Ahmad Iftikhar

Advisor: Muhammad Latif Anjum Co-Advisor: Wajahat Hussain

This project designs a modular, programmable robot aimed at educational and introductory robotics applications using Scratch-based programming. The robot consists of disassemblable components supporting easy reconfiguration and equipped with color, distance, and touch sensors. Line-following functionality is implemented using infrared sensors and a microcontroller platform such as the Arduino Uno. The design prioritizes accessibility and modularity to support beginners in learning fundamental robotics and programming concepts. The system serves as a practical, hands-on educational tool for early STEM engagement.

Ababeel: An AI-Driven Swarming Drone Network

Group Members: Ahmed Hussain | Muhammad Atif | Sudais Akbar Khan

Advisor: Sadiq Amin Co-Advisor: Salman Abdul Ghafoor

This project develops an intelligent adaptive drone swarm, IntelliSwarm, designed to operate in dynamic environments with decentralized control. A hierarchical architecture designates a primary master drone to coordinate slave drones, with automatic role reassignment to any slave upon master failure detection. Machine learning algorithms drive data-based decision-making, environmental awareness, and adaptive mission execution across the swarm. The system is built on cost-effective hardware with modular integration, real-time communication, and fault-tolerant protocols. Target applications include surveillance, search-and-rescue, and environmental monitoring requiring scalable, autonomous aerial coordination.

AI-Driven Remote Cardiovascular Health Monitoring Using Wearable Biosignals

Group Members: Amna Nadeem Khan | Haffi Sajid | Muhammad Ahmad

Advisor: Nazia Perwaiz Co-Advisor: Sidra Sultana

This project develops an AI-powered wearable system for continuous remote cardiovascular health monitoring using non-invasive multimodal biosignals. Wearable sensors including ECG, PPG, and SCG/PCG capture heart rate, blood oxygen saturation, heart rate variability, and blood pressure in real time. Machine learning and deep learning models process the physiological data streams to detect life-threatening events such as arrhythmias and early signs of heart failure decompensation. The compact, low-power system is designed for integration into wearable devices enabling persistent at-home patient monitoring. The project transforms reactive cardiovascular care into a proactive, data-driven diagnostic approach through continuous AI-powered biosignal analysis.

Cloud-Connected ML Telemetry Retrofit Device for Solar Inverters

Group Members: Muhammad Attique | Muhammad Hassan

Advisor: Hassaan Khaliq Qureshi Co-Advisor: Neelma Naz

This project designs a plug-and-play external retrofit device that adds real-time telemetry and ML-driven monitoring to existing household solar inverters without requiring internal modification. The embedded system fuses AC metering and DC sensing data at the edge and publishes it through a secure local API and cloud dashboard for remote visibility. An ML advisory layer delivers explainable alerts for events such as wiring faults, battery abuse risk, brownout conditions, and load-shedding recommendations under low-generation scenarios. Compact predictive models combine power-quality metrics, short-term historical trends, and weather forecasts to provide actionable operational guidance. The device extends inverter lifetimes, reduces e-waste, and lowers the overall cost of solar power system ownership.

02 Knowledge Group
Computer Engineering

Skin Impedance Based Melanoma Detection

Group Members: Abeer Fiaz Hussain | Dure Adan Ali Khan

Advisor: Usman Khan Co-Advisor: Muhammad Daud Abdullah Asif

Melanoma is the most dangerous form of skin cancer, with approximately 325,000 new cases diagnosed globally in 2020 alone, requiring early detection for effective treatment. This project exploits measurable differences in electrical skin impedance between healthy and malignant tissue to enable non-invasive melanoma detection. COMSOL Multiphysics simulations are used to design electrodes and model impedance variation caused by melanoma lesions at different positions, depths, and sizes. Convolutional neural networks (CNNs) and graph neural networks (GNNs) are applied to classify impedance data and enhance detection accuracy. The project aims to deliver a reliable, non-invasive diagnostic tool achieving high accuracy in melanoma classification using bioimpedance spectroscopy.

Design and Verification of RISC-V Vector Processor IP

Group Members: Maheen Abdullah | Muhammad Abdullah | Sarah Yasrab

Advisor: Muhammad Imran Co-Advisor: Abid Rafique

This project focuses on the design and verification of a RISC-V vector extension processor IP targeting high-performance parallel data processing. Vector processing is widely used in computationally intensive domains including scientific research, cryptography, bioinformatics, and financial simulations. The work covers complete RTL design and functional verification of the RISC-V vector extension across a broad range of parallel workloads. Key design goals include high throughput, functional correctness, and compatibility with the RISC-V ecosystem. The verified IP is intended to serve as a reusable hardware block for integration into RISC-V-based System-on-Chip designs.

RF Fingerprinting for IoT Device Security Using Deep Learning

Group Members: Muhammad Ibtasam Amir | Rabia Rani

Advisor: Muhammad Shahzad Younis Co-Advisor: Arbab Latif

RF fingerprinting uses unique, unintentional hardware imperfections in wireless transmitters to authenticate IoT devices at the physical layer, providing a defense against spoofing attacks. This project designs a deep learning model utilizing CNNs and Siamese Networks to classify and authenticate devices based on their distinctive RF characteristics. Unlike conventional cryptographic methods, RF fingerprints are inherent to hardware and extremely difficult to replicate or forge. The system enables detection of unauthorized devices even among physically identical units from the same manufacturer. The approach provides a scalable, hardware-intrinsic security solution for large-scale IoT deployments.

Design of a CMOS Bandgap Reference IC

Group Members: Qasim Bilal

Advisor: Usman Khan Co-Advisor: Khurram Javed

This project designs and simulates a Bandgap Reference (BGR) circuit in TSMC 130nm CMOS technology using Cadence Virtuoso to generate a stable, temperature-independent voltage reference of approximately 1.2V. The BGR is essential for ensuring consistent operation of ADCs, DACs, PLLs, voltage regulators, and power management ICs across varying temperature and process conditions. Conventional topologies including the Brokaw cell are studied, with the design evaluated for temperature coefficient, PSRR, line and load regulation, and power consumption. Schematic design, simulation across process corners, and performance evaluation are the primary project deliverables. Layout design and post-layout simulation are also considered to provide hands-on experience with full-flow analog IC design.

Edge-AI Accelerator: FPGA-Powered Real-Time Diagnosis and Report Generation

Group Members: Muhammad Huzaifa | Muhammad Umair Ajmal | Zeeshan Haider

Advisor: Nazia Perwaiz Co-Advisor: Muhammad Imran

This project builds an FPGA-based AI accelerator for real-time disease detection and automated report generation on portable devices without requiring internet connectivity. FPGA deployment enables extremely low latency, high energy efficiency, and strong data privacy compared to cloud-based inference solutions. Deep learning models are quantized and deployed directly at the edge for onboard diagnostic processing. The system automatically generates reports alongside detection results, supporting clinical workflows in resource-limited and remote environments. The project demonstrates the practical feasibility of edge AI acceleration for healthcare diagnostic applications.

A Federated Learning Framework for Intelligent Threat Profiling and Secure Access in IoT Systems

Group Members: Amna Siddiqui

Advisor: Sadiq Amin Co-Advisor: Sajjad Hussain

This project implements a federated learning-based security framework for IoT systems using embedded edge devices to preserve data privacy while enabling collaborative threat detection. Local machine learning models are trained on individual IoT devices without sharing raw data; only encrypted model parameters are aggregated at a central server. This decentralized approach maintains data sovereignty, reduces communication overhead, and scales effectively to large IoT deployments. The framework targets detection of cyber threats including spoofing and unauthorized access at the device level. The system provides a privacy-preserving, scalable security solution suitable for large-scale heterogeneous IoT networks.

ASIC design of AES Rijndael

Group Members: Abdullah Awais | Ahmad Abdullah | Muhammad Dawood Arslan

Advisor: Hammad M Cheema Co-Advisor: Sharjeel Khilji

This project designs an Application-Specific Integrated Circuit (ASIC) implementing the AES Rijndael encryption cipher, targeting high performance and fabrication readiness. The design follows the complete ASIC development flow from RTL design through synthesis, place-and-route, and final GDS-II file generation. Functional correctness and reliability are validated using Universal Verification Methodology (UVM)-based testbenches across comprehensive test scenarios. The design is optimized to meet timing, area, and power constraints required for semiconductor tape-out. The final deliverable is a verified, performance-optimized GDS-II file implementing the AES block cipher ready for fabrication.

High Speed AI accelerator on FPGA for real-time applications

Group Members: Khansa Mishqat | Muhammad Saad Farooq | Muqaddas Masood

Advisor: Mohsin Kamal Co-Advisor: Muhammad Imran

This project implements and accelerates a selected AI algorithm on an FPGA platform to demonstrate hardware-level performance improvements over software execution. The algorithm is first profiled on a standard software framework to establish a baseline computational delay before FPGA deployment. Parallelism and hardware optimization techniques using Xilinx tooling and Verilog HDL are applied to substantially reduce inference runtime. The project bridges algorithmic development and hardware acceleration, demonstrating the practical benefits of FPGA-based computing for real-time AI workloads. Key deliverables include a working FPGA implementation and a comparative performance analysis against the software baseline.

03 Knowledge Group
Electrical Engineering

Design and Deployment of Quality Assurance Automation System of Call Center using OpenAI

Group Members: Akash | Muhammad Ibadullah Hammad | Syed Anas Hussani

Advisor: Wajid Mumtaz Co-Advisor: Sajjad Hussain

This project develops an intelligent Quality Assurance automation system for call centers powered by the OpenAI API. The system automatically analyzes customer service calls to evaluate agent performance, detect sentiment, and generate actionable insights. Advanced natural language processing and large language models replace manual QA reviews with a scalable, data-driven approach. A user-friendly dashboard provides performance visualization, automated scoring, and real-time feedback for supervisors. The goal is to improve service quality and operational efficiency across call center environments.

An AI-based diagnostic involving X-ray images and facial photos to detect multiple diseases

Group Members: Huzaifa Akhtar | Muhammad Talha

Advisor: Wajid Mumtaz Co-Advisor: Muhammad Imran

This project develops an AI-based diagnostic device that analyzes both X-ray images and facial photographs to detect multiple diseases using deep learning. Convolutional neural networks identify signs of lung, heart, and other conditions from X-rays while facial features provide indicators of additional health problems. AI models are deployed on an FPGA for high-speed, low-power hardware acceleration without reliance on cloud connectivity. Combining multimodal imaging with FPGA processing enables rapid and accurate multi-disease detection at the point of care. The system is designed to support clinical decision-making, particularly in resource-limited healthcare settings.

Deep Learning based Drone Detection and Tracking

Group Members: Abdullah Khan | Ali Ahmad | Mohammad Owais

Advisor: Usman Zabit Co-Advisor: Ahsan Shabbir

Drone detection has become critical for safety in public spaces and restricted airspace as unmanned aerial vehicle usage grows rapidly. This project develops a Raspberry Pi or Jetson Orin-based system that employs deep learning for real-time drone detection and tracking in live video. The system covers both model training and on-device inference, integrated with an image processing pipeline for continuous operation. The design targets accurate identification and sustained tracking of drones across varying environments and lighting conditions. The project addresses the limitations of traditional detection methods against increasingly sophisticated and miniaturized UAV platforms.

Analog Front-End for EEG Signal Acquisition in Neurofeedback Therapy

Group Members: Minahel Ahsan

Advisor: Hammad M Cheema Co-Advisor: Saman Fatima

This project designs an advanced analog front-end amplifier for reliable EEG signal acquisition in ADHD neurofeedback therapy applications. The amplifier suppresses low-frequency noise, eliminates DC offsets, and preserves subtle brainwave activity including the theta/beta ratio critical for ADHD biomarker detection. Its low power consumption and compact design make it suitable for wearable or at-home neurofeedback devices, extending therapy access beyond clinical settings. The design undergoes thorough literature review, simulation, layout, and post-layout verification using industry-standard tools. The system enables accurate, artifact-free neural signal capture to support effective and continuous ADHD treatment.

Drone-Assisted Crop Disease Detection, Phenotyping, and Smart Spraying

Group Members: Ahmad Hussain | Muhammad Ishaq

Advisor: Muhammad Daud Abdullah Asif Co-Advisor: Maajid Maqbool

This project develops an integrated UAV and IoT system for real-time crop disease detection, plant phenotyping, and precision-targeted spraying in agricultural fields. Aerial imaging using RGB, NDVI, and thermal cameras captures comprehensive crop health data for early identification of diseases and assessment of high-yield plant varieties. IoT sensor data from the field supplements aerial imagery to provide a complete, multi-source crop monitoring pipeline. Targeted spraying is activated based on detected disease hotspots, minimizing chemical usage while maximizing effectiveness. The system demonstrates the application of precision agriculture technologies for sustainable, data-driven crop management.

Smart Load Management for Optimally Improved Power Economy

Group Members: Afnan Khan | Hira Zahid

Advisor: Tassawar Kazmi Co-Advisor: Wajid Mumtaz

This project develops a smart energy meter with an intelligent load management system for efficient, automated power distribution under constrained grid conditions. Current and voltage sensors monitor consumer loads in real time, with an ESP32 microcontroller executing prioritized load shedding decisions based on grid conditions and cost functions. Adaptive cost functions from the utility enable automated partial load shedding that preserves critical loads while avoiding full blackouts. The system supports user-selected tariff plans and dynamic load priority adjustments without relying on battery storage infrastructure. A mobile dashboard provides real-time monitoring and remote control with optional integration of local renewable energy generation.

04 Knowledge Group

Robotics, Instrumentation & Measurement Systems

Vital Sign Monitoring using mm-Wave Radar Technology

Group Members: Abdussalam Sarmad | Muhammad Taaha Hashmi

Advisor: Nosherwan Shoaib Co-Advisor: Muhammad Shahzad Younis

This project implements non-contact vital sign monitoring using millimeter-wave (mm-wave) FMCW radar operating at 60 or 77 GHz, detecting minute chest displacements caused by breathing and heartbeats. The radar analyzes phase changes in reflected signals to separate respiratory movements (1–12 mm) from the much smaller cardiac displacements (0.1–0.5 mm). Advanced signal processing algorithms including Discrete Wavelet Transform (DWT) and Fast Fourier Transform (FFT) extract the physiological signatures from the combined radar return. The non-contact nature of the system makes it suitable for sleep monitoring, ICU patient care, and elderly health surveillance. The project delivers a functional radar-based vital sign monitoring platform validated on human subjects.

SMART ROAD WITH WIRELESS POWER TRANSFER CAPABILITIES FOR EVs

Group Members: Abdullah Khalid | Ameer Hamza | Hizbullah Khan

Advisor: Ahsan Azhar Co-Advisor: Tassawar Kazmi

This project develops a smart road infrastructure system for wireless charging of electric vehicles (EVs) while stationary or in motion, targeting the elimination of range anxiety. Electromagnetic induction technologies, primarily Inductive Power Transfer (IPT) and resonant inductive coupling, are embedded in the road surface to transfer power to receiver coils mounted on vehicles. The design explores coil geometry, frequency matching, and alignment tolerance to maximize power transfer efficiency across practical air gaps of 10 to 40 cm. The system aims to reduce dependency on large vehicle batteries by enabling continuous roadway-based charging. The project evaluates design feasibility, power transfer efficiency, and scalability for practical deployment on public roadways.

Distribute Aperture System (DAS) for Immersive Multi-camera Fusion

Group Members: Muhammad Ammar

Advisor: Tauseef ur Rehman Co-Advisor: Muhammad Ashraf

This project designs and implements a real-time multi-camera fusion system that generates a seamless panoramic field of view projected onto a VR headset, demonstrating core Distributed Aperture System (DAS) principles. The system performs intrinsic and extrinsic camera calibration, synchronized time-aligned video capture, and geometric warping onto a unified projection plane. Alpha and multi-band blending methods reduce visual seams in overlapping image regions for a smooth panoramic output. The fused panoramic video is integrated into a VR headset for immersive visualization with a limited panoramic field of view. Performance is evaluated based on latency, frame synchronization accuracy, and user-perceived visual quality and comfort.

AI based Smart Power Management System

Group Members: Mian Abdullah Afzal | Muhammad Hasnain Tajammal | Muhammad Usman Khawar

Advisor: Nosherwan Shoaib Co-Advisor: Tassawar Kazmi

This project develops an AI and IoT-integrated Smart Power Management System for real-time monitoring, demand forecasting, and optimization of energy consumption. Machine learning models analyze historical usage data to forecast energy demand and make automated decisions for dynamic load balancing across smart buildings, EV charging stations, and industrial facilities. Adaptive HVAC and lighting control, demand response automation, and Vehicle-to-Grid (V2G) energy management are key deployment use cases targeting

energy savings of 23 to 31 percent. Real-time optimization balances supply and load continuously, reducing operational costs and stabilizing grid performance during peak demand periods. The system replaces static rule-based energy management with an intelligent, self-optimizing platform.

05 Knowledge Group
Smart Telecommunication Systems & Networks

Analyzing Federated Learning Techniques in Quantum Computing Environments for Quantum Federated Learning (QFL) Applications

Group Members: Mohammad Hamza Ijaz | Muhammad Haris

Advisor: Hassaan Khaliq Qureshi Co-Advisor: Salman Abdul Ghafoor

Federated learning enables collaborative ML model training across distributed participants without sharing raw data, preserving privacy and security. This project analyzes the feasibility and challenges of adapting federated learning to quantum computing platforms using Qiskit as a simulation framework. Distributed learning scenarios are modeled on quantum circuits, investigating the effects of noise and limited qubit resources. The study benchmarks quantum-based federated learning against classical implementations for convergence, resource efficiency, and resilience to errors. The expected outcome is a comprehensive understanding of design considerations for deploying scalable, secure quantum federated learning systems.

IOT based Module for Controlling Contactors

Group Members: Ahmad Nasir | RanoMal

Advisor: Salman Abdul Ghafoor Co-Advisor: Abdullah Mughees

This project designs an IoT-based hardware and software module for remotely monitoring and controlling industrial contactors used in motor and valve switching applications. The hardware module interfaces directly with contactors and communicates wirelessly over Wi-Fi using industrial protocols such as Modbus RTU. A computer-based graphical user interface enables operators to monitor contactor status and perform remote switching with full visibility. The system also supports trend logging and automated report generation for operational records. The solution addresses the need for remote control and digital management of conventional industrial switching equipment.

AI-Powered Drone System for Early Wildfire Detection and Prevention

Group Members: Ayesha Hussain | Nayab Nazar

Advisor: Rizwan Ahmad Co-Advisor: Salman Abdul Ghafoor

Wildfires pose a growing threat to ecosystems and communities, often spreading undetected in remote areas before conventional systems can respond. This project develops an AI-powered drone system for early wildfire detection using computer vision, thermal imaging, and onboard environmental sensor data. Autonomous drone navigation using SLAM and GPS enables continuous surveillance of large forested areas with minimal human intervention. Onboard edge AI inference delivers real-time fire detection and GPS-tagged early warning notifications directly to firefighting agencies and disaster response teams. A web and mobile dashboard provides remote monitoring, live fire visualization, and predictive analytics to support rapid, coordinated intervention.

Age-Aware Deep Reinforcement Learning for Resource Allocation in 6G- Enabled IoT networks

Group Members: Arooj Fatima | Muddassir Sadiq | Muhammad Sufyan Haider

Advisor: Syed Ali Hassan Co-Advisor: Huma Ghafoor

This project proposes an AI-driven, age-aware scheduling framework using deep reinforcement learning (DRL) to optimize resource allocation in 6G-enabled IoT networks. The framework jointly optimizes the freshness of information (Age of Information), energy sustainability, and network throughput under realistic constraints. Cognitive radio and non-orthogonal multiple access (CR-NOMA) are integrated alongside energy harvesting and queue dynamics for comprehensive network performance management. DRL-based decision-making

enables real-time adaptive responses to changing channel conditions and fluctuating device demands. The research demonstrates significant improvements in supporting timely, energy-efficient data delivery for industrial automation and autonomous IoT applications in 6G infrastructure.

A communication system that monitors blood glucose for Type-II diabetics

Group Members: Bushra Rehman | Sarah Omer | Seemab Ramzan

Advisor: Huma Ghafoor Co-Advisor: Syed Ali Hassan

Diabetes is a chronic disease requiring regular blood glucose monitoring for safe and effective management. This project develops a non-invasive blood glucose monitoring system that measures blood sugar levels without requiring blood samples, using intelligent sensing technology. Communication capabilities enable real-time data transmission and remote monitoring of patient glucose levels for ongoing diabetes management. The system leverages advanced sensing modalities to provide a convenient and pain-free alternative to conventional finger-prick measurement methods. The project aims to improve monitoring compliance and quality of life for Type-II diabetic patients through accessible, technology-enabled glucose tracking.

Design and Development of a Quantum Random Number Generator (QRNG)

Group Members: Imran Ali

Advisor: Salman Abdul Ghafoor Co-Advisor: Rizwan Ahmad

This project designs a Quantum Random Number Generator (QRNG) that exploits quantum noise in semiconductor laser emission to generate true, hardware-based random numbers. Spontaneous emission and vacuum fluctuations in the laser output produce inherently unpredictable phase and intensity variations that serve as the entropy source. The laser is operated under optical feedback to produce a chaotic output, which is photodetected and digitized using an analog-to-digital converter to generate a random bit stream. The resulting bits can be used directly or combined via XOR operations with a parallel setup to enhance statistical randomness quality. The project demonstrates a practical, hardware-based approach to generating cryptographically secure random numbers for security applications.

06 Knowledge Group
Miscellaneous

Performance Enhanced RISC-V Vector Processor

Group Members: Haseeb Umer | Irfa Farooq | Sataish Elahi

Advisor: Abid Rafique Co-Advisor: Muhammad Imran

This project enhances an existing RISC-V vector processor implementation based on the ratified RVV 1.0 extension for high-throughput parallel computing. It targets AI, high-performance computing, and signal processing workloads that benefit from data-level parallelism. The design adopts Vector Length Agnostic (VLA) principles, enabling scalability across hardware with varying vector lengths without requiring recompilation. Key optimizations include custom vector extensions, multi-precision tensor units, and optimized memory access patterns to maximize computational throughput. The outcome is a performance-improved RISC-V vector processor delivering higher efficiency for parallel data-intensive applications.

Ultra Low Power RISC-V Microprocessor

Group Members: Ameen Ahmed | Jalaluddin Yousaf | Yousaf Hassan

Advisor: Muhammad Imran Co-Advisor: Haroon Waris

This project designs and implements an ultra-low-power RISC-V processor targeting energy-constrained embedded and IoT applications. Three key power optimization techniques are employed: clock gating, power gating, and Dynamic Voltage and Frequency Scaling (DVFS). The open-source, modular RISC-V ISA is chosen for its suitability for research-driven low-power customization. The processor is designed to deliver functional correctness while demonstrating significant energy savings over conventional implementations. The work addresses the growing demand for energy-efficient computing in resource-constrained devices.

Displacement Sensing using a Laser Feedback Sensor

Group Members: Noor Fatima Masud | Sabika Fatima

Advisor: Usman Zabit Co-Advisor: Arbab Latif

This project develops an improved signal processing algorithm for extracting motion information from a laser feedback sensor signal based on Self-Mixing Interferometry (SMI). Building on a previously published design, the improved algorithm is implemented in C or MATLAB, with optional FPGA or microcontroller hardware deployment. Laser feedback interferometry enables non-contact, high-precision displacement measurement using laser reflections that re-enter the laser cavity without external optics. The technique is inherently auto-aligned and suitable for compact, cost-effective sensing systems. The project aims to improve measurement accuracy and signal extraction robustness over the existing baseline implementation.

Real-time Embedded System for Laser Sensing

Group Members: Agha Mushaf Raza | Ibraheem Hasnain

Advisor: Usman Zabit Co-Advisor: Muhammad Jameel Nawaz Malik

This project implements a real-time embedded hardware system for laser-based motion sensing, requiring high-speed data acquisition at a minimum of 10 MSps. The system processes signals from a laser feedback interferometry sensor and targets deployment on FPGAs or DSP and microcontroller boards such as ESP32 or ARM Cortex-M7. Key applications include industrial inspection, autonomous navigation, and robotic tracking that demand sub-millisecond response times. The primary challenge lies in meeting stringent sampling rate and real-time processing requirements within embedded hardware constraints. The project delivers a functional embedded sensing platform validated against laser signal extraction performance benchmarks.

ATTENDANCE SYSTEM VIA SMART FACE RECOGNITION SYSTEM

Group Members: Abdul Rafay Naeem

Advisor: Wajid Mumtaz Co-Advisor: Sajjad Hussain

This project builds a face recognition-based smart attendance system that integrates machine learning with embedded microcontroller hardware. A laptop running Python performs real-time facial recognition, mask detection, and liveness verification using a built-in camera, while an STM32F429I microcontroller manages peripheral control including buzzer, LED, and LCD outputs. Attendance records are transmitted via ESP8266 Wi-Fi or serial communication and automatically uploaded to Google Sheets for cloud-based management. The system provides automated, secure, and contactless attendance tracking suitable for academic and institutional environments. It integrates edge processing with cloud storage to deliver a complete, end-to-end attendance management solution.

Edge-Deployed 3D Vision and Localization for Autonomous Systems

Group Members: Maleeha | Rayyan Naeem Muzaffar

Advisor: Muhammad Jameel Nawaz Malik Co-Advisor: Wajid Mumtaz

This project develops an edge-deployed autonomous perception system combining monocular and stereo 3D vision with visual SLAM for real-time localization and mapping. The system estimates vehicle pose and reconstructs surrounding structure without GPS or dedicated depth sensors, using a simulated environment for development and validation. Vision-based perception modules enable human detection and collision-aware navigation in dynamic operational settings. Designed for resource-constrained edge platforms, the system emphasizes efficiency, modularity, and scalability for autonomous vehicle and robotic applications. The project delivers a complete onboard perception pipeline capable of real-time spatial awareness without external infrastructure.

Design of CMOS Instrumentation Amplifier for Spectroscopic Skin Bioimpedance Characterization

Group Members: Faareha Sajjad

Advisor: Usman Khan Co-Advisor: Khurram Javed

This project designs a CMOS instrumentation amplifier (IA) for precise skin bioimpedance measurement across a frequency spectrum, intended for skin cancer detection and hydration analysis. The IA supports a four-wire bioimpedance spectroscopy system that characterizes skin layers beneath the highly insulating stratum corneum. The design is implemented using Cadence Virtuoso and includes both schematic and layout stages for eventual integration into a skin bioimpedance measurement system. Key performance objectives include high common-mode rejection ratio, low noise, and stable gain across the relevant measurement frequency range. Performance is validated through detailed simulation and post-layout verification.

Parwaaz: A Secure Autonomous Drone Delivery Platform

Group Members: Sarah Ali | Sikandar Raza | Wahhaj Waheed | Yusra Amal

Advisor: Abdullah Mughees Co-Advisor: Salman Abdul Ghafoor

This project designs an autonomous drone delivery platform with a focus on payload security and safe operation across diverse environments. A custom secure delivery box remains locked until the recipient's identity is digitally verified at the destination, ensuring package integrity throughout transit. The system supports both manual pilot control and fully autonomous mission execution with sophisticated flight planning algorithms. A novel zipline mechanism allows the drone to hover at altitude and lower packages to the ground, enabling deliveries to inaccessible or restricted landing zones. The project addresses limitations in drone logistics by prioritizing security, flexibility, and streamlined delivery operations.

Programmable educational Robot with Multiple Functionalities

Group Members: Muhammad Abdullah Masood | Muhammad Adeel | Muhammad Sohaib | Warda Hakeem

Advisor: Muhammad Latif Anjum Co-Advisor: Neelma Naz

This project creates a modular, programmable educational robotic kit designed to teach STEM concepts to school-level students through hands-on interaction. The robot supports both block-based programming with Scratch and text-based programming with Python, supporting a progressive learning curve for different skill levels. Modular hardware components with various sensors allow students to assemble, program, and reconfigure the robot for different tasks. The design prioritizes affordability, ease of use, and classroom compatibility to make robotics education accessible. The kit provides a practical platform for developing coding, engineering, and problem-solving skills in young learners.

Subscription payments based crypto ecosystem

Group Members: Bushra Naeem | Malaika Amer | Muhammad Arbaaz Alam Khan | Muhammad Essa

Advisor: Syed Taha Ali Co-Advisor: Fahd Sikander khan

This project builds a blockchain-based ecosystem for managing recurring subscription payments using cryptocurrencies, eliminating traditional banking intermediaries. Smart contracts automate billing cycles, ensuring secure, transparent, and tamper-proof payment records on a decentralized platform. The system reduces transaction fees, removes currency conversion barriers, and enables global accessibility for both businesses and users. Participants benefit from enhanced financial control, privacy, and immutable transaction records through decentralized wallets. The project demonstrates a practical application of blockchain and smart contract technology to recurring payment management in fintech services.

Design of a RISC-V based Symmetric Multi-processor Architecture

Group Members: Aized Soban | Muhammad Hassan Akram | Umer Farooq

Advisor: Hammad M Cheema Co-Advisor: Sharjeel Khilji

This project designs, implements, and verifies a RISC-V-based Symmetric Multiprocessor (SMP) architecture to improve computational performance beyond single-core frequency scaling limits. The design is first explored in the gem5 simulator for performance analysis before RTL implementation, targeting a shared memory architecture scalable to eight cores. Consistent memory access bandwidth across all cores is maintained through careful interconnect and cache design. RTL verification using UVM confirms functional correctness, followed by physical design through to the GDS-II stage. The project provides a complete path from architectural simulation to a chip-ready multiprocessor design.

Hardware Accelerator for the Number Theoretic Transform in Kyber

Group Members: Aneeq Ur Rehman | Muhammad Hashir Aslam | Muhammad Zohaib Mustafa

Advisor: Muhammad Imran Co-Advisor: Madiha Khalid

Post-quantum cryptographic schemes such as CRYSTALS-Kyber rely on the Number Theoretic Transform (NTT) for polynomial operations, making efficient hardware implementation critical. This project develops an optimized NTT hardware architecture addressing bottlenecks including limited memory bandwidth, inefficient modular reduction, and redundant computation stages. Architectural refinements improve data flow, parallelism, and computation efficiency over an existing baseline design. The design is evaluated for improvements in speed, area, and power consumption across implementation metrics. The expected outcome is a high-throughput, resource-efficient NTT accelerator contributing toward practical and deployable post-quantum cryptographic hardware.

Impact-SoC: RISC-V SoC with In-Memory Computing Accelerator

Group Members: Fatima Tariq | Muhammad Ali | Muhammad Hussnain | Sarah Sohail

Advisor: Muhammad Imran Co-Advisor: Abid Rafique

The von Neumann memory wall limits AI system performance by causing frequent, energy-intensive data transfers between processor and memory, motivating In-Memory Computing (IMC) approaches. This project advances a prior SRAM-based In-Memory Computing Unit (IMCU), building upon it through architectural optimization, comprehensive RTL verification, and physical design. The enhanced SoC integrates in-memory vector processing with a RISC-V core, an optimized DMA subsystem, and improved accumulation structures to achieve higher throughput and reduced latency. The design targets efficient parallel computation for AI

workloads at the edge while remaining within practical power and area budgets. The deliverable is a synthesizable, verified, and physically realizable in-memory accelerator chip demonstrating energy-efficient AI inference.

LiDAR Analog Front-end Chip for Automotive Applications

Group Members: Muhammad Abdullah Asim

Advisor: Hammad M Cheema Co-Advisor: Saman Fatima

LiDAR is a critical sensing technology for autonomous vehicles, enabling precise 3D environment mapping for obstacle detection and safe navigation. This project designs an Analog Front-End (AFE) chip integrated with a multiplexed ADC/TDC in TSMC 65nm or 28nm CMOS technology for automotive LiDAR receiver applications. The AFE is optimized for low noise, low power, and high dynamic range to accurately capture time-of-flight signals from reflected laser pulses. The project encompasses literature review, baseline design, detailed circuit simulation, layout, and post-layout verification. The outcome is a high-performance LiDAR AFE chip design contributing to cost-effective, compact automotive sensing solutions.

ML based Hardware Accelerator for Real Time Image Segmentation on FPGA

Group Members: Awais Asghar | Muhammad Haris

Advisor: Hammad M Cheema Co-Advisor: Musadiq Hussain

This project implements a hardware-accelerated encoder-decoder neural network for real-time image segmentation on an FPGA platform. A U-Net-based model is trained on a relevant dataset and subsequently quantized for deployment on the FPGA, exploiting hardware parallelism for low-latency inference. The design minimizes resource utilization while maximizing throughput, targeting real-time performance without cloud connectivity. System performance is benchmarked against CPU and GPU implementations in terms of inference speed, accuracy, and hardware resource efficiency. Target applications include autonomous vehicles, medical diagnostics, and industrial automation requiring real-time scene understanding.

Real-Time 360° Image Stitching on FPGA for Panoramic Vision Systems

Group Members: Abdul hadi Afzal | Ali Masood Khan | Umar Bin Shakil

Advisor: Hammad M Cheema Co-Advisor: Musadiq Hussain

This project develops an FPGA-based system for real-time 360° panoramic image stitching using feature detection algorithms such as SURF, SIFT, or ORB. Multiple input image streams are processed in hardware through feature extraction, feature matching, and homography computation to produce a seamless panoramic output. The FPGA's parallel processing architecture enables real-time execution of computationally intensive stitching operations across multiple camera inputs simultaneously. Design goals include minimal hardware resource utilization while maximizing stitching speed and output visual quality. The system targets applications in autonomous vehicles, augmented reality, and aerial imaging that require continuous high-speed panoramic video.

Sharp: Secure Hardware Accelerator for ASCON in Post-Quantum IoT

Group Members: Abdul Hannan Adil | Abdullah | Hasnat Ahmed Gill

Advisor: Muhammad Imran Co-Advisor: Madiha Khalid

This project designs hardware accelerators for post-quantum authenticated encryption algorithms targeting resource-constrained IoT devices deployed on FPGA platforms. A key challenge is achieving efficient area and low power consumption while protecting against side-channel attacks (SCAs) such as power analysis and electromagnetic leakage. Countermeasures against SCAs are integrated directly into the hardware architecture to prevent secret key extraction. The design balances cryptographic robustness with the strict resource constraints typical of IoT environments. The outcome is a secure, practical hardware accelerator demonstrating viable post-quantum security for constrained IoT deployments.

Snap: Neuromorhpic Accelerator for Spiking Neural Networks

Group Members: Ahmed Jamil | Muneeb Ur Rehman | Umar Abdullah AlJeelani

Advisor: Muhammad Imran Co-Advisor: Sadiq Amin

This project designs a dedicated neuromorphic hardware accelerator optimized for Spiking Neural Networks (SNNs), which use sparse, event-driven computation for greater energy efficiency than conventional deep learning. Specialized hardware modules are developed for spike encoding, neuron dynamics simulation, and synaptic weight updates. The architecture exploits parallelism and memory locality to reduce latency and power consumption compared to traditional GPU and CPU-based SNN execution. Target applications include real-time pattern recognition, edge intelligence, and low-power IoT devices. The project aims to demonstrate significant improvements in energy efficiency and throughput over conventional hardware platforms for neural network inference.

VeriLLM: LLM-Accelerated UVM Testbench Development

Group Members: Hamza Ahmad | Hasan Ahmad" | Muhammad Arham Siddiqui

Advisor: Muhammad Imran Co-Advisor: Haroon Waris

Creating UVM verification environments for complex IC designs is increasingly time-consuming and resource-intensive using manual methodologies. This project proposes an AI-driven framework that automatically generates reusable UVM testbench skeletons from structured natural language prompts describing the design under test. The generated code includes all key components such as agents, drivers, monitors, scoreboards, and coverage collectors, adhering to industry best practices. The framework reduces testbench setup time and improves engineer productivity across diverse IP cores and SoC subsystems. Future extensions plan to incorporate coverage-driven stimulus generation and formal verification integration for comprehensive next-generation IC verification.

Wideband 7 – 24 GHz Tunable Variable Gain Amplifier for 6G Applications

Group Members: Mian Tahir Nadeem | Muhammad Murtaza Baig | Talha Rashid

Advisor: Hammad M Cheema Co-Advisor: Salman Abdul Ghafoor

This project designs a wideband tunable Variable Gain Amplifier (VGA) operating across the 7–24 GHz frequency range to support 6G mid-band (FR3) spectrum requirements. The VGA serves as a critical transmitter front-end component enabling adaptive gain control, power efficiency, and linear signal transmission across a wide bandwidth. Tunable gain and frequency flexibility support dynamic spectrum utilization and link adaptation demanded by next-generation 6G wireless systems. Key design metrics include gain flatness, linearity, power efficiency, and tuning range across the full operating bandwidth. The design contributes toward enabling high-performance, flexible RF front-end hardware for future 6G transceivers.

Thermally tuned Integrated MZI for Laser Sensing

Group Members: Shehryar Khan

Advisor: Usman Zabit Co-Advisor: Wajid Mumtaz

This project designs a thermally tuned integrated Mach-Zehnder Interferometer (MZI) for laser sensing applications on a silicon nitride (SiN) photonic platform. Thermal actuation of the MZI enables precise control of the optical path length difference, supporting accurate interferometric sensing of physical parameters. The device is designed for fabrication in collaboration with LAAS-CNRS, France, leveraging the low propagation loss and broadband transparency of the SiN platform. The integrated photonic design aims to achieve compact, stable, and highly sensitive laser sensing performance. The project contributes to the development of miniaturized, chip-scale photonic sensors for advanced measurement systems.

Baymax: Your Personal Health Companion

Group Members: Ahmed | Ali Ahsan | Arsal Amin | Noumaan Mashood

Advisor: Neelma Naz Co-Advisor: Khawaja Fahad Iqbal

This project designs an advanced autonomous medical robot for intelligent, non-invasive patient monitoring and interaction in dynamic hospital environments. The robot integrates state-of-the-art robotics and artificial intelligence to support clinical staff with routine monitoring tasks and patient interaction. It is designed to be adaptive, safe, and trustworthy, capable of autonomous navigation through busy hospital wards. The system aims to reduce clinical workload while improving the consistency and quality of routine patient monitoring. The

project focuses on building a scalable, robust robotic platform demonstrating practical deployment capability in real healthcare settings.

Lidar-Guided Rover for Landmine Detection

Group Members: Muhammad Abu Bakr Hashim | Muhammad Khizer Sheraz | Muhammad Umer Haroon

Advisor: Neelma Naz Co-Advisor: Muhammad Latif Anjum

This project develops an autonomous rover for humanitarian landmine detection using LiDAR-guided navigation and magnetometer-based subsurface sensing. LiDAR enables precise autonomous path planning and obstacle avoidance across unstructured terrain, while the magnetometer identifies metallic landmines beneath the ground surface. Upon detection, the rover records GPS coordinates, transmits data to a ground control interface, and physically marks the location using an automated spray-painting mechanism. The system integrates real-time sensing, autonomous mobility, and geographic data mapping to enhance the safety and efficiency of demining operations. Its cost-effective, scalable design aims to reduce human risk during mine clearance missions.

Secure AI-Driven Healthcare System for Disease Diagnosis and Patient Management

Group Members: Aima Ghaffar | Muhammad Uzair Wajeeh | Syed Muhammad Azeem Ul Hassan

Advisor: Rizwan Ahmad Co-Advisor: Salman Abdul Ghafoor

This project develops an AI-driven healthcare management system integrating automated disease diagnosis, patient-doctor connectivity, and hospital workflow automation. Deep learning models analyze medical images for early detection of diseases including malaria and pneumonia, while large language models provide real-time patient guidance. Role-Based Access Control, Multi-Factor Authentication, end-to-end encryption, and blockchain audit logs collectively safeguard sensitive patient records against unauthorized access and tampering. Appointment scheduling, resource tracking, and emergency patient-doctor connectivity are automated through the unified platform. The system addresses both diagnostic accuracy and healthcare data security challenges, particularly for resource-limited and remote healthcare settings.

SignLink: Bridging Communication Through Vision and AI

Group Members: Haida Asif | Syed Shaheer Raza Naqvi

Advisor: Salman Abdul Ghafoor Co-Advisor: Sadiq Amin

SignLink is a mobile application bridging communication between deaf and hearing individuals using real-time computer vision and machine learning. The app captures hand gestures through the smartphone camera, recognizes them in real time, and translates them into both English and Urdu text. For reverse communication, hearing users select preset replies that are immediately displayed to the deaf user as sign language videos. The system is built locally and operates online, providing an intuitive and accessible two-way communication interface. The project aims to meaningfully reduce communication barriers for the deaf and hard-of-hearing community through AI-powered gesture recognition.

AI-Powered Social Media Assistant for Content Generation and Automated Publishing

Group Members: Muhammad Abdullah

Advisor: Ayesha Kanwal Co-Advisor: Farzana Jabeen

This project develops an AI-powered conversational assistant that automates the entire social media content creation and publishing workflow. Through an interactive interface, the system collects user inputs such as content goals, tone, and target audience to generate customized posts including captions and hashtags. Content is intelligently adapted to the requirements and format conventions of each selected social media platform. Scheduling and automated publishing are handled through integrated social media tools without requiring manual intervention. The assistant significantly reduces the time and effort required for social media content management and distribution.

Argus: AI-Driven Environmental and Social Impact Monitoring Using NASA Satellite Data

Group Members: Afnan Mirza | Shazib Ali

Advisor: Syed Taha Ali Co-Advisor: Arshad Nazir

This project develops an AI-powered system for monitoring environmental conditions and their social impacts using open-source NASA satellite imagery. Machine learning and computer vision techniques analyze satellite data to detect and quantify changes in smog levels, green cover, and surface water availability over time. The environmental insights generated have direct implications for public health, agriculture, and urban planning and living conditions. The system is designed to support data-driven decision-making for disaster response, sustainable development, and environmental policy formulation. The project bridges space-based remote sensing capabilities with on-ground social outcome analysis for broader societal benefit.

Olive Yield Prediction using Computer Vision and Edge computing

Group Members: Hafiz Muhammad Ahmed Safdar | Muhammad AbuBakar Farooq

Advisor: Sajjad Hussain Co-Advisor: Wajid Mumtaz

This project develops computer vision algorithms for automated olive detection and yield estimation deployed on NVIDIA Jetson Nano edge hardware in the field. High-resolution orchard imagery is processed locally on the edge device, eliminating cloud latency and enabling real-time in-field yield analysis without network dependency. The system transitions olive farming from manual, experience-based estimation to a precise, data-driven automated approach. Accurate yield predictions support optimized harvest timing, labour planning, and logistics management for olive growers. The project demonstrates the practical value of edge computing and computer vision for precision agriculture.

Taak: Vision-Guided Laser Tracking System for Autonomous Drone Missions

Group Members: Ahmed Rafiq | Fateha Kamran | Muhammad Ibrahim

Advisor: Sadiq Amin Co-Advisor: Salman Abdul Ghafoor

This project develops an autonomous drone system for tracking user-designated objects while maintaining a precise standoff distance using a 2D laser tracking module and computer vision. A real-time image processing pipeline provides robust object detection and identification for continuous tracking across diverse environments. The drone employs yaw movement to compensate for the 2D laser's limitation, effectively achieving pseudo-3D tracking of moving targets. Advanced navigation algorithms maintain constant distance and orientation relative to the target throughout mission execution. Applications include surveillance, automated inspection, and dynamic object pursuit requiring sustained, precise aerial observation.

AI enhanced Intelligent Nonlinear Control Framework for Biomedical Systems

Group Members: Aown Aamir | Huzaifa Ahmad | Muhammad Hammad Sarwar

Advisor: Sadiq Amin Co-Advisor: Salman Abdul Ghafoor

This project develops a bio-inspired ornithopter UAV that mimics the flight dynamics of birds such as eagles or bats for discreet surveillance applications. An indigenously designed aerodynamic body, integrated circuit, and bio-inspired control system based on control theory are developed to maximize flight time and energy efficiency. Material selection, efficient propulsion mechanisms, and sophisticated control algorithms are optimized to minimize energy consumption during extended flight. The design enables persistent and covert aerial observation suitable for a range of surveillance applications where conventional drones would be conspicuous. The project bridges biological flight dynamics with modern UAV engineering for next-generation autonomous aerial platforms.

Ghaat: Autonomous Detection, Tracking, and Neutralization of Rogue UAVs

Group Members: Adeeba Wazir | Muhammad Talha Hassan | Shameer Ashraf

Advisor: Rizwan Ahmad Co-Advisor: Adeel Mumtaz

This project designs an autonomous counter-UAV system that detects, tracks, and neutralizes rogue drones using onboard computer vision and image processing. The system autonomously identifies and tracks a designated target UAV in real time, maintaining a safe standoff distance throughout the pursuit. Upon reaching close proximity, a specialized net deployment mechanism entangles the target drone's propellers, disabling it safely and non-lethally. Both autonomous and manual operational modes are supported, providing operational flexibility across different security scenarios. The system targets airspace security, critical infrastructure protection, and law enforcement applications requiring effective, non-lethal drone neutralization.

Digital Twin for UAV Swarms

Group Members: Abdul Mohiz Naseer | Ali Taimoor Khalid | Muhammad Taaha Younas

Advisor: Rizwan Ahmad Co-Advisor: Sajjad Hussain

This project develops a Digital Twin (DT) that serves as a high-fidelity virtual replica of a physical UAV swarm for real-time simulation, monitoring, and behavior optimization. The DT enables predictive analysis, fault detection, and risk-free testing of complex swarm coordination behaviors before physical deployment. Bidirectional synchronization between the virtual and physical swarms supports real-time closed-loop control and mission optimization. The system facilitates mission planning, performance benchmarking, and iterative refinement of swarm communication and control protocols. The project contributes to safer, more reliable UAV swarm operations across surveillance, logistics, and defense application domains.

Edge DPI on Raspberry Pi for Real-Time Anomaly Detection in SDN-Enabled IWSNs

Group Members: Abdullah Munir | Muhammad Saad Kashif

Advisor: Hassaan Khaliq Qureshi Co-Advisor: Rizwan Ahmad

This project develops an AI-driven Deep Packet Inspection (DPI) system for real-time anomaly detection in Industrial Wireless Sensor Networks (IWSNs) integrated with Software-Defined Networking (SDN). Federated learning is implemented across Raspberry Pi nodes, each hosting a local AI model and a DPDK-accelerated DPI engine, with a centralized server performing global model aggregation. This distributed approach enables detection of both known and novel anomalies while preserving data privacy and optimizing resource usage on constrained hardware. SDN integration enables dynamic policy enforcement and adaptive threat mitigation in industrial environments. The system enhances the security, resilience, and adaptability of IWSNs against evolving cyber threats.

Intelligent Control of SIM-Assisted Wireless Networks Using Deep Reinforcement Learning

Group Members: Manahil Ahmad | Muhammad Abubaker

Advisor: Syed Ali Hassan Co-Advisor: Huma Ghafoor

This project applies deep reinforcement learning (DRL) to intelligently control Stacked Intelligent Metasurface (SIM)-assisted wireless networks for advanced 6G communications. SIMs extend the capabilities of conventional Reconfigurable Intelligent Surfaces by enabling complex wave-domain signal processing at unprecedented speed. DRL provides a model-free optimization framework for jointly controlling SIM configurations and transmission parameters in real time without requiring explicit channel models. The approach addresses the system complexity and non-convex optimization challenges introduced by multi-layer SIM integration. The result is a robust, adaptive control framework capable of meeting the high data rate and connectivity demands of future 6G wireless networks.

Intelligent Resource Allocation in O-RAN

Group Members: Aleesha Waqar | Mamona Sadaf

Advisor: Salman Abdul Ghafoor Co-Advisor: Arsalan Ahmad

This project designs an AI and ML-based intelligent resource allocation framework for the Open Radio Access Network (O-RAN) architecture. Key use cases include dynamic spectrum allocation, traffic load balancing, QoS-aware scheduling, and energy-efficient resource management within programmable RAN components. Both the Near-Real-Time RIC and Non-Real-Time RIC components of O-RAN are utilized to execute control decisions across different operational time scales. The solution is validated in a virtualized O-RAN testbed

environment using open-source platforms such as OSC RIC or OAI. The project demonstrates how programmable, AI-driven O-RAN components can enhance network performance, spectrum efficiency, and energy sustainability.

Optimization of NOMA-Enabled Backscatter Communication Using Deep Reinforcement Learning in Diverse RIS-Aided Wireless Systems

Group Members: Muhammad Danish Khattak

Advisor: Syed Ali Hassan Co-Advisor: Huma Ghafoor

This project investigates DRL-based optimization of NOMA-enabled wireless backscatter communication systems enhanced by diverse types of Reconfigurable Intelligent Surfaces (RIS). A unified, scenario-agnostic framework jointly optimizes RIS element configurations, transmit power levels, resource allocation timings, and backscatter parameters in real time. The DRL agent adapts to changing channel conditions and user demands without relying on explicit mathematical channel models. The design supports multiple RIS deployment scenarios, enabling flexible, intelligent optimization for varying performance objectives. The project contributes toward scalable, adaptive wireless communication systems for next-generation IoT and 6G networks.

Realtime RIS Optimization for 6G networks using Multi Agent Framework

Group Members: Muhammad Ashar Javid

Advisor: Syed Ali Hassan Co-Advisor: Huma Ghafoor

Traditional RIS control methods rely on static, model-based optimization that fails to adapt under real-world dynamics such as user mobility and fast-fading wireless channels. This project develops a multi-agent reinforcement learning framework for real-time adaptive control of Reconfigurable Intelligent Surfaces (RIS) in 6G wireless networks. Multiple intelligent agents continuously monitor changing channel conditions and autonomously reconfigure RIS elements to maintain optimal network performance. The system addresses scalability and resilience gaps in existing RIS optimization approaches that limit practical 6G deployment. The outcome is a dynamic, self-adapting RIS management system suitable for next-generation 6G infrastructure.

Visual drone tracking

Group Members: Muhammad Ibrahim | Muhammad Zakwaan | Syed Saleh Bin Nasir

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Advisor: Rizwan Ahmad Co-Advisor: Muhammad Daud Abdullah Asif

This project develops a vision-based drone seeker system for detecting and tracking low-altitude FPV kamikaze drones using an onboard RGB camera. An image processing and deep learning pipeline identifies and continuously tracks enemy drones in real time, supporting autonomous interception missions. The system is designed as a cost-effective and agile counter-drone solution addressing the limitations of traditional air defense systems against small, inexpensive UAV threats. The design prioritizes fast detection latency, robust tracking under challenging conditions, and seamless integration with the interceptor drone's flight control system. Applications include defense, border security, and critical infrastructure protection against rogue UAV incursions.

Smart PLC-Based Multi-Source Power Management System with Cost Optimization and Maintenance-Aware Switching

Group Members: Hanzla Sajjad | Muhammad Umair

Advisor: Dr. Mian Ilyas Co-Advisor: Salman Abdul Ghafoor

This project implements a PLC-based multi-source power management system integrating a WAPDA grid, two generators, and a UPS for seamless uninterrupted power supply. When the grid fails, the UPS immediately supplies critical loads while the PLC selects the most suitable generator based on battery status, fuel levels, and load demand. Cost-based source selection compares per-kilowatt-hour costs between grid and generator power, automatically switching to the more economical source when conditions permit. Protection relays provide overcurrent and overvoltage safeguards, with dedicated maintenance lines ensuring continued operation during equipment servicing. An HMI interface provides operators with real-time visibility and control over all sources, loads, fuel levels, and system alarms.

Towards 6G: SDN-based intelligent integrated communication network

Group Members: Asiya Ali | Ayesha Nahman

Advisor: Huma Ghafoor Co-Advisor: Salman Abdul Ghafoor

This project develops an SDN-based intelligent integrated communication network targeting next-generation 6G wireless systems. The architecture integrates terrestrial and aerial base stations operating as SDN controllers to form a unified, programmable network. Machine learning techniques enable intelligent, adaptive routing decisions that maximize delivery ratio while minimizing end-to-end delay across diverse network environments. The system aims to provide seamless, high-performance connectivity across heterogeneous integrated network segments. The work contributes to the design and validation of scalable, AI-driven 6G integrated communication infrastructure.

Intelligent Physical Layer Security in HAPS-Integrated 6G Networks

Group Members: Hafiza Adeela Arif | Momina Nadeem | Naeem Ullah

Advisor: Syed Ali Hassan Co-Advisor: Muhammad Moazzam Ali

This project designs AI and ML-based physical layer security (PLS) mechanisms for High-Altitude Platform Station (HAPS)-integrated 6G networks to protect against eavesdropping and impersonation. Techniques including AI-enhanced secret key generation, deep neural network-based intelligent codebook design, and RF fingerprinting are employed to maximize secrecy capacity at the air interface. HAPS nodes in the stratosphere introduce unique wide-area security vulnerabilities that adaptive signal processing and real-time channel awareness aim to mitigate. The system dynamically maximizes signal strength for legitimate users while minimizing signal leakage to potential eavesdroppers. The project advances physical layer security for next-generation air-to-ground wireless communication architectures.

Reinforcement Learning-based Performance Optimization of BackScatter Systems with Practical Constraints

Group Members: Ahraf Fatima | Hamza Irshad Bhatti | Wassi Haider Kabir

Advisor: Syed Ali Hassan Co-Advisor: Huma Ghafoor

This project applies deep reinforcement learning (DRL) to optimize NOMA-based backscatter communication systems under realistic practical constraints including imperfect Successive Interference Cancellation (SIC) and imperfect Channel State Information (CSI). The DRL agent dynamically controls transmitted power and system parameters to maximize communication performance despite the degrading effects of these real-world imperfections. Unlike traditional static optimization approaches, the RL framework adapts in real time to dynamic IoT channel environments without requiring prior channel knowledge. The system demonstrates how model-free adaptive optimization can overcome the performance limitations imposed by practical system constraints. The project contributes toward robust, self-optimizing backscatter communication systems for next-generation IoT deployments.

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