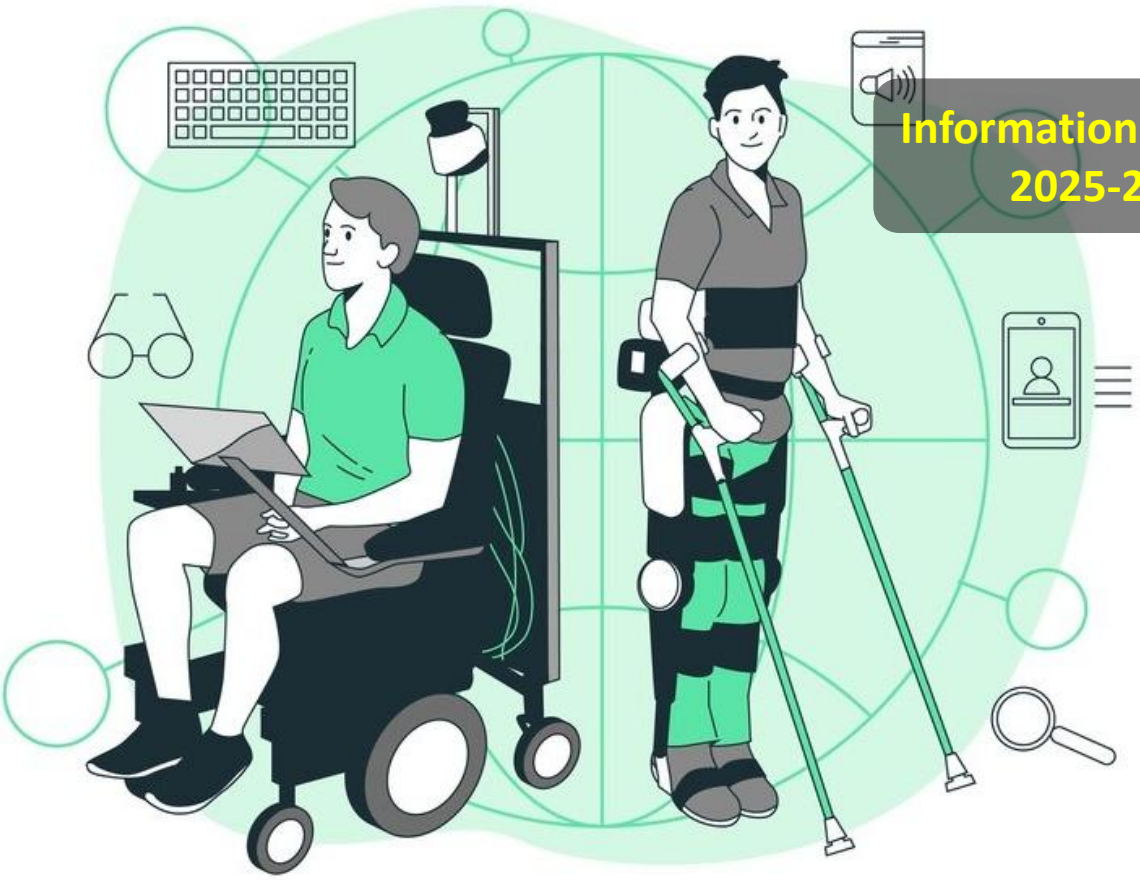
IARE
INSTITUTE OF
AERONAUTICAL ENGINEERING

NAAC ACCREDITATION A++ GRADE
NBA NATIONAL BOARD OF ACCREDITATION
nirf INDIA RANKINGS 2024 TOP 200 ENGINEERING RANK 151-200 TOP 50 INNOVATION RANK 11-50

Technology Innovation & Product Support (TIPS)

AT – Assistive Technologies



Information Packet
2025-26

IARE
INSTITUTE OF
AERONAUTICAL ENGINEERING
25 YEARS 2000 2025

Appreciate IARE students who are showing interest in the Assistive Technologies (AT) Project Program at the Institute of Aeronautical Engineering!

The Assistive Technologies product team comprises B.Tech students, research scholars, and faculty members collaboratively working on innovative solutions to empower individuals with disabilities and support inclusive living. This innovation theme focuses on designing intelligent assistive systems using Artificial Intelligence (AI), Machine Learning (ML), Internet of Things (IoT), and Human–Computer Interaction (HCI) technologies. ML algorithms play a crucial role in gesture recognition, speech-to-text conversion, predictive healthcare monitoring, smart prosthetics, and adaptive user interfaces. These intelligent systems help enhance communication, mobility, learning, and independence for people with diverse needs. This product fosters the development of next-generation inclusive solutions, contributing to improved quality of life, accessibility, and social equity.

Goals for Product Development in Assistive Technologies

Design and Develop Smart Communication Aids
Create real-time speech-to-text and text-to-speech systems, sign language recognition tools, and AI-powered voice assistants to bridge communication barriers.

Integrate Multi-Sensor Supportive Devices
Combine data from wearable sensors, cameras, biosignals, and IoT devices to develop adaptive tools for mobility assistance, health tracking, and daily activity monitoring.

Implement Personalized Learning and Interaction Interfaces
Develop ML-based adaptive learning platforms and customized interfaces that adjust to a user's preferences, abilities, and real-time feedback.

Enhance Mobility and Accessibility
Design AI-driven smart wheelchairs, prosthetics with sensor fusion, and navigation aids (e.g., obstacle detection for the visually impaired) to ensure safety and independence.

Create User-Friendly Control and Monitoring Platforms
Build dashboards and mobile apps that allow caregivers and family members to monitor user health, issue alerts, and provide remote assistance.

Ensure Affordability and Sustainability
Optimize hardware and software components to make assistive technologies cost-effective, energy-efficient, and widely deployable.

Test and Validate in Real-World Scenarios
Deploy prototypes in healthcare centers, educational institutes, and community environments to assess performance across varied use cases.

Enable Customization for Diverse Needs
Ensure flexibility in design so that products can adapt to users with physical, sensory, cognitive, or learning impairments, as well as for elderly care.

The research theme of this AT product initiative also aligns with the challenges and opportunities presented by the **United Nations Sustainable Development Goals (SDGs)** particularly SDG 3 (Good Health and Well-Being), SDG 4 (Quality Education), and SDG 10 (Reduced Inequalities).

IARE Sustainability Development Goals (SDGs) highlighted with Blue Colour Font	
SDG #1	End poverty in all its forms everywhere
SDG #2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
SDG #3	Ensure healthy lives and promote well-being for all at all ages
SDG #4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
SDG #5	Achieve gender equality and empower all women and girls
SDG #6	Ensure availability and sustainable management of water and sanitation for all
SDG #7	Ensure access to affordable, reliable, sustainable and modern energy for all
SDG #8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
SDG #9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
SDG #10	Reduce inequality within and among countries
SDG #11	Make cities and human settlements inclusive, safe, resilient and sustainable
SDG #12	Ensure sustainable consumption and production patterns
SDG #13	Take urgent action to combat climate change and its impacts
SDG #14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
SDG #15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
SDG #16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
SDG #17	Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

The following research domains are recommended for Assistive Technologies projects, and selected students should find the research gap and frame the problem statements from any one of the themes below.

S.No	Name of the Theme	SDGs
1	AI-Powered Communication Aids (Speech-to-Text, Sign Language Recognition)	SDG #10
2	Smart Mobility Solutions for Differently Abled (Wheelchairs, Prosthetics, Navigation Aids)	SDG #3
3	Inclusive Learning Platforms with Adaptive Interfaces	SDG #4
4	Wearable and IoT-Based Health Monitoring Devices	SDG #3
5	Affordable and Sustainable Assistive Devices for Community Integration	SDG #11

To participate in **Assistive Technologies Innovation Projects**, you must formally apply and be accepted by the project coordinator. To proceed, please contact the project coordinator, **Dr. Y Pandu Rangaiah** (y.pandurangaiah@iare.ac.in), Associate Professor, Department of ECE. This process will help you explore all available open positions aligned with autonomous vehicle technologies.

When submitting your project proposal and updated résumé, please include a clear statement explaining why you are interested in contributing to the Assistive Technologies development team. Your motivation, along with any prior experience in healthcare innovation, embedded systems, human–computer interaction, rehabilitation devices, or AI applications, will help determine team placement.

Please note that participation in the assistive technology product development initiative requires registration under a valid research or design project title focused on key domains such as smart prosthetics, accessibility solutions, sensor-based rehabilitation, AI-driven communication aids, or inclusive learning platforms. More detailed information, guidelines, and deliverables will be shared with all selected applicants who are offered a position.

If you have any questions regarding a specific sub-project or specialization track, feel free to reach out to the assigned faculty mentor(s) for further clarification.

We strongly encourage you to explore this impactful opportunity to work on real-world assistive technology systems. We look forward to your application and the meaningful innovations you will help create for inclusive and accessible living!

AI-Powered Communication Aids

Dr. Y Pandu Rangaiah, Associate Professor, ECE, Faculty Mentor

GOALS

AI-Powered Communication Aids aim to remove barriers between people with hearing, speech, or motor impairments and the hearing/voicing world by enabling accurate, real-time two-way communication. Core objectives include live captioning for spoken conversations, meeting/classroom accessibility, robust recognition and translation of sign languages (e.g., ISL/ASL/BSL), and seamless integration with phones, wearables, kiosks, and telehealth platforms. Additional goals are personalization (speaker/adaptor tuning), low-latency offline operation for unreliable networks, support for code-switching and regional languages, and privacy-preserving on-device inference for sensitive contexts such as clinics, courts, and classrooms.

METHODS & TECHNOLOGIES

Key methods and technologies used in AI-Powered Communication Aids include:

Automatic Speech Recognition (ASR): Streaming end-to-end models (RNN-T/CTC/Transducer, Conformer) with noise-robust enhancement, diarization, punctuation restoration, and domain adaptation (medical/education).

Natural Language Processing: Error correction, entity highlighting, summarization, multilingual translation, and intent extraction to turn captions into actionable notes.

Text-to-Speech (TTS) & Voice Banking: Neural TTS (Tacotron/Glow/FastSpeech) with speaker cloning to support users with degenerative conditions via AAC devices.

Sign Language Recognition (SLR):

- **Vision-based:** 2D/3D pose estimation (skeleton keypoints), hand-shape detection, and spatio-temporal Transformers/3D-CNNs for continuous sign and fingerspelling recognition.
- **Sensor-based:** EMG/IMU smart-gloves for low-light or occluded settings; multimodal fusion with video for higher accuracy.

Human–Computer Interaction (HCI): Accessible UI with large captions, adjustable reading speeds, haptic cues, and AR overlays (e.g., smart glasses subtitles).

Edge & Systems Engineering: On-device inference (DSP/NPU), quantization/distillation, caching, and fail-safe offline modes; secure sync to EHR/LMS/meeting apps via accessibility APIs.

Compliance & Ethics: Data minimization, consent flows, secure logs, and adherence to accessibility standards (WCAG/EN 301 549) and local regulations.

MAJORS & AREAS OF INTEREST

Computer Science & Engineering: ASR/SLR modeling, multimodal learning, LLM-assisted correction and translation, edge deployment.

Electronics & Communication / Embedded Systems: Low-power hardware, sensor integration (EMG/IMU), DSP pipelines, Bluetooth/USB HID for AAC.

Biomedical Engineering & Rehabilitation: Clinical validation with speech-language pathologists, usability studies, outcome measures.

Human–Computer Interaction & UX: Inclusive design, AR captions, eye-gaze/gesture input for users with limited mobility.

Linguistics & Deaf Studies: Sign linguistics (phonology, grammar), corpus creation for ISL and regional variants, glossing and annotation.

Data Science & Analytics: Domain adaptation, personalization, evaluation dashboards (WER/CER, BLEU, Top-k, latency, user satisfaction).

Researchers and developers in this theme build end-to-end, privacy-aware systems that deliver dependable captions, sign understanding, and expressive synthesis improving access to education, employment, healthcare, and civic participation.

MENTOR CONTACT INFORMATION

Dr. Y Pandu Rangaiah
Email: y.pandurangaiah@iare.ac.in

PARTNERS & SPONSORS

None

Smart Mobility Solutions for Differently Abled

Dr. Y Pandu Rangaiah, Associate Professor, ECE, Faculty Mentor

GOALS

Design and deploy intelligent, safe, and affordable mobility systems that restore or augment independent movement for users with diverse motor impairments. Focus areas include: powered wheelchairs with obstacle-aware autonomy, smart prosthetics and exoskeletons that adapt to the user's intent and environment, and indoor/outdoor navigation aids with multi-sensory guidance. Outcomes target improved Activities of Daily Living (ADL) performance, reduced caregiver burden, and inclusive access to education, employment, and transit prioritizing reliability, low latency, and privacy-aware operation.

METHODS & TECHNOLOGIES

User Intent & Control: Myoelectric EMG/EEG decoding, eye-gaze, sip-and-puff, head-pose/joystick hybrids; adaptive filters and intent classifiers for robust control.

Perception & Autonomy (Wheelchairs/Exoskeletons): Multi-sensor fusion (RGB-D/LiDAR/ultrasonic/IMU), curb/ramp detection, free-space segmentation, fall/tilt prediction; SLAM and local planning for doorway/aisle navigation.

Prosthetics & Exoskeletons: Low-latency motor control, impedance/admittance control, series-elastic actuation, FES integration; socket comfort sensing and automatic gain tuning.

Navigation Aids: UWB/BLE beacons for indoor wayfinding, GNSS + map matching outdoors, haptic/audio AR cues, collision-risk alerts at crossings/elevators.

Edge Systems & Power: On-device inference (quantization/distillation on MCU/DSP/NPU), battery health and energy-aware planning, modular CAN/ROS 2 architectures.

Safety, Testing & Compliance: ISO 7176 (wheelchairs), ISO 13485/QMS, IEC 60601, risk management (ISO 14971), accessibility standards and data-minimization by design.

Evaluation & Personalization: Metrics for gait symmetry, Timed Up and Go (TUG), curb-climb success rate, localization accuracy, Mean Time Between Failures, user comfort/NPS; per-user calibration profiles and cloud-optional logs.

MAJORS & AREAS OF INTEREST

Computer Science & Engineering: Perception, planning, intent decoding, embedded AI; simulation and digital twins for safety validation.

Electronics & Communication / Embedded Systems: Sensor integration (EMG/IMU/UWB), low-power motor drivers, safety interlocks, real-time comms.

Mechanical/Robotics & Mechatronics: Prosthetic/exoskeleton design, ergonomics, series-elastic actuation, lightweight frames, suspension for wheelchairs.

Biomedical Engineering & Rehabilitation: Clinical protocols, outcome measures, socket/orthotic fit, co-design with therapists and end-users.

Human–Computer Interaction (HCI) & UX: Inclusive controls, multimodal feedback (haptic/sonification), AR captions/overlays for wayfinding.

Data Science: Telemetry analytics, anomaly detection, personalization models, reliability dashboards.

Researchers and developers in this theme collaborate to deliver dependable mobility combining perception, intent understanding, and safe actuation so users can navigate homes, campuses, and cities with confidence.

MENTOR CONTACT INFORMATION

Dr. Y Pandu Rangaiah
Email: y.pandurangaiah@iare.ac.in

PARTNERS & SPONSORS

None

Inclusive Learning Platforms with Adaptive Interfaces

Dr. Y Pandu Rangaiah, Associate Professor, ECE, Faculty Mentor

GOALS

Inclusive Learning Platforms with Adaptive Interfaces aim to remove learning barriers for students with diverse abilities (sensory, motor, cognitive, neurodivergent) by blending pedagogy with accessibility-first design. Core goals include: (1) real-time adaptation of content, interaction, and feedback to learner needs; (2) multimodal input/output (text, speech, sign, haptics, visuals) to ensure equitable access; (3) analytics-driven personalization that preserves privacy; and (4) interoperability so supports follow the learner across courses, devices, and bandwidth conditions. Outcomes target improved engagement, retention, independence, and demonstrable learning gains across formal and informal education settings.

METHODS & TECHNOLOGIES

Adaptive UI/UX & Personalization Engines: preference profiles; dynamic font, spacing, contrast, color filters; reading modes (focus, distraction-free); keyboard-only/eye-gaze/switch control; latency-aware layouts for low bandwidth.

Multimodal Accessibility Stack: high-accuracy speech-to-text (live captions, transcription), text-to-speech with SSML, sign-language recognition/avatars, image/diagram alt-text generation, haptic cues, and language simplification.

Assistive Input Integrations: eye-tracking, head pointers, sip-and-puff, braille displays, AAC devices; shortcut layers and macro builders for complex tasks.

Learning Science & AI: knowledge tracing, mastery models, and recommendation systems that adjust difficulty, pacing, and modality; explainable AI to justify adaptations.

Standards & Compliance: WCAG 2.2 AA-aligned components; ARIA roles; IMS LTI, QTI, SCORM/xAPI for plug-and-play with LMS/VLEs.

Privacy, Safety, and Governance: on-device inference where possible; consented data collection; secure profiles that travel with the learner; audit trails for accommodations.

Localization & Inclusivity: multilingual interfaces (including regional languages), culturally relevant content, offline packs for intermittent connectivity, device-agnostic delivery (mobile/desktop/TV).

MAJORS & AREAS OF INTEREST

Computer Science & Engineering
Focus: accessibility engineering, HCI, recommender systems, NLP/ASR/TTS, on-device AI.

Data Science & Learning Analytics
Focus: knowledge tracing, fairness metrics, A/B testing of accommodations, causal evaluation.

Electronics & Assistive Robotics
Focus: sensor fusion for alternative inputs, haptic/refreshable braille integrations.

Design & Human-Centered Computing
Focus: inclusive design, usability testing with diverse learners, information architecture.

Special Education & Educational Technology
Focus: UDL (Universal Design for Learning), accommodation policies, curriculum integration.

Researchers and developers in this theme will prototype end-to-end inclusive learning journeys from accessible content authoring to adaptive delivery and assessment measured through usability, accessibility conformance, learning outcomes, and learner/teacher satisfaction.

MENTOR CONTACT INFORMATION

Dr. Y Pandu Rangaiah
Email: y.pandurangaiah@iare.ac.in

PARTNERS & SPONSORS

None

Wearable and IoT-Based Health Monitoring Devices

Dr. Y Pandu Rangaiah, Associate Professor, ECE, Faculty Mentor

GOALS

This theme focuses on end-to-end systems that continuously measure physiological signals and contextual data—then turn them into timely, actionable insights for patients, caregivers, and clinicians. Core goals are: (1) reliable, 24×7 sensing of vital signs and activities; (2) on-device/edge analytics for early anomaly detection; (3) secure, standards-based data exchange with EHR/LIS; and (4) inclusive design that works across ages, abilities, and connectivity levels. Target outcomes include reduced hospitalizations, better chronic-disease self-management, faster triage, and measurable improvements in quality of life.

METHODS & TECHNOLOGIES

Multi-sensor Wearables & Nearables: PPG/ECG for HR/HRV/arrhythmia; SpO_2; skin temperature; GSR/EDA (stress); IMU-based gait/fall detection; cuffless BP; respiratory rate; sleep staging; smart patches and rings.

IoT Edge & Connectivity: Bluetooth LE, NFC, Zigbee/Thread, Wi-Fi, 4G/5G, LPWAN (LoRaWAN, NB-IoT); adaptive duty-cycling, energy harvesting, OTA updates, fail-safe firmware.

Edge AI & Cloud Analytics: lightweight models (TinyML) for on-device inference; anomaly detection, personalization via transfer learning; digital twins; trend dashboards and clinician alerts.

Interoperability & Data Models: HL7-FHIR resources, IEEE 11073, Open mHealth schemas, xAPI for rehabilitation exercises; SMART-on-FHIR app integration.

Safety, Privacy, and Compliance: secure boot, HW enclaves, end-to-end encryption, consent management, audit trails; clinical validation workflows (bench testing, pilot studies, sensitivity/PPV reporting).

Human Factors & Accessibility: skin-tone-aware PPG calibration; hypoallergenic materials; one-hand don/doff; haptic/audio cues; multilingual UI; offline first for low-bandwidth environments.

Reliability & QA: sensor fusion, motion-artifact suppression, calibration routines, battery health analytics, ISO 13485-aligned documentation and risk registers (ISO 14971).

MAJORS & AREAS OF INTEREST

Computer Science & Engineering
Focus: embedded ML/TinyML, anomaly detection, secure mobile apps, interoperability.

Electronics & Biomedical Engineering
Focus: sensor design, analog front-ends, low-power MCU/SoC, signal processing.

Data Science & Health Informatics
Focus: longitudinal modeling, risk scoring, FHIR pipelines, cohort analytics.

Design & Human-Centered Computing
Focus: wearable ergonomics, accessibility, compliance UX, adherence coaching.

Public Health & Clinical Streams
Focus: study design, outcomes measurement, real-world evidence, care pathways.

Researchers and developers will prototype device-to-dashboard pipelines wearable firmware, companion apps, secure data backends, clinician portals and validate against ground truth to demonstrate sensitivity/specificity, latency, battery life, and user adherence.

MENTOR CONTACT INFORMATION

Dr. Y Pandu Rangaiah
Email: y.pandurangaiah@iare.ac.in

PARTNERS & SPONSORS

None

Affordable and Sustainable Assistive Devices for Community Integration

Dr. Y Pandu Rangaiah, Associate Professor, ECE, Faculty Mentor

GOALS

The goal of this theme is to design and deliver cost-effective, durable, and environmentally sustainable assistive devices that empower differently abled individuals to live independently and participate fully in community life. Core objectives include: (1) lowering barriers to access by focusing on affordability without compromising safety or quality; (2) leveraging sustainable materials and circular design principles to reduce environmental footprint; (3) ensuring cultural and contextual fit for rural and urban communities; and (4) supporting long-term usability, repairability, and inclusive adoption. Outcomes emphasize enhanced mobility, communication, and self-reliance while fostering dignity and social inclusion.

METHODS & TECHNOLOGIES

Low-Cost Fabrication & Materials: 3D-printed components, bamboo composites, recycled plastics, biodegradable polymers, modular design for part replacement.

Sustainable Power & Energy: solar-charging, kinetic energy harvesters, low-power electronics, long-life rechargeable batteries.

Core Device Categories: mobility aids (wheelchairs, walkers, crutches), prosthetics/orthotics, hearing and vision support, daily-living assistive kits, adaptive sports tools.

IoT & Smart Extensions: basic sensor add-ons (fall detection, GPS tracking, environmental alerts) integrated into otherwise passive aids for enhanced safety.

Inclusive Design Approaches: co-creation with users, ergonomic studies for comfort, culturally appropriate designs, universal design principles.

Cost-Reduction Strategies: open-source hardware/software, community-driven repair hubs, micro-manufacturing clusters, partnerships with local NGOs and SHGs.

Sustainability & Lifecycle: recyclable packaging, repair kits, modular upgrades, cradle-to-cradle certification pathways, community-based recycling initiatives.

MAJORS & AREAS OF INTEREST

Mechanical & Manufacturing Engineering
Focus: low-cost fabrication, biomechanics, modular systems, life-cycle engineering.

Electronics & Mechatronics
Focus: embedded controllers, sensor integration, low-power electronics.

Materials Science & Environmental Engineering
Focus: eco-friendly composites, biodegradable polymers, sustainable material cycles.

Computer Science & IoT Applications
Focus: basic IoT health/safety extensions, offline-first applications, data privacy.

Social Work, Design & Public Policy
Focus: co-design with users, accessibility standards, community deployment models, policy frameworks.

Researchers and developers in this theme will prototype scalable, context-appropriate solutions validated through usability, affordability, durability, and sustainability metrics while ensuring broad community adoption and long-term impact.

MENTOR CONTACT INFORMATION

Dr. Y Pandu Rangaiah
Email: y.pandurangaiah@iare.ac.in

PARTNERS & SPONSORS

None