# Bidyut Saha

PhD Scholar
Embedded AI and TinyML
Researcher

*Indian Institute of Technology Kharagpur, India*
📱 *+91 9051668691*
✉ *sahabidyut999@gmail.com*
🌐 *https://bidyutsaha.github.io*
in *linkedin.com/in/sahabidyut*

---

## Objective

PhD candidate specializing in **TinyML, Embedded AI, Edge AI, and sustainable low-power machine learning**, with a focus on advancing AI solutions for **resource-constrained environments**. Expertise in on-device model personalization, hardware-aware neural architecture search (NAS), and model compression techniques. Actively seeking a Research Scientist role to contribute to cutting-edge advancements in Embedded AI and TinyML for low-power, efficient AI systems.

## Education

**2020–2025**   **PhD in Embedded AI and TinyML**, *Indian Institute of Technology, Kharagpur*, India
Research focus: TinyML, AIoT, Computer Vision, Embedded AI, and low-power machine learning models on resource-constrained devices.

**2018–2020**   **M.Tech in Computer Science**, *University of Calcutta*, India

**2013–2016**   **B.Tech in Computer Science and Engineering**, *University of Calcutta*, India

**2010–2013**   **B.Sc (Honours) in Computer Science**, *Asutosh College, University of Calcutta*, India

## Research Projects

**2022–2023**   **On-device Human Activity Detection in Wearables**, *TinyML and Embedded AI Project*
- Developed a smart band prototype using **ESP32 VROOM** with integrated IMU sensors on a custom PCB, housed in a 3D-printed case, costing under $12 per unit.
- Built a web application and Android app for data collection and labeling, utilizing **BLE** and Wi-Fi with **MQTT, Flask, and MongoDB**. The solution supports deployment across cloud, desktop, or Raspberry Pi, and integrates a lightweight ML model for real-time on-device human activity recognition, eliminating the need for computation offloading.

**2023–2024**   **Human Activity Model Personalization**
- Designed a cloud-based framework for personalizing human activity models and automating their deployment to smart bands.
- Developed a framework for **on-device training** within Android environments for model personalization and domain adaptation for individual users.

**2024–Present**   **GPU-free Neural Architecture Search (NAS) Tool**
- Developed a hardware-aware NAS tool optimized for TinyML on resource-constrained devices. The tool operates on **CPU-only systems** without relying on GPUs, implementing model compression techniques for efficient deployment on embedded systems.
- Integrated a time-bound search for model architecture optimization, allowing rapid deployment.

| 2024–Present | **Channel Pruning with Genetic Algorithm for TinyML Deployment** |
|---|---|
| | ○ Created a tool for **channel pruning**, enabling model optimization for extreme resource-constrained hardware like MCUs. |
| | ○ Leveraged **L2 norm** for determining channel importance and applied genetic algorithms to optimize pruning percentages for each layer. |
| 2023–2024 | **Gesture Recognition for Human-Computer Interaction Systems** |
| | ○ Implemented on-device gesture recognition using IMU sensors in wearable devices to control nearby connected devices, enabling hands-free interaction. |
| | ○ Developed a static hand gesture recognition model using **image sensors** and deployed it on an ESP32 CAM, achieving a detection range of 2.5 meters. The system is designed to be low-cost, low-power, and privacy-preserving for gesture control. |
| 2024–Present | **Real-time On-device Face Tracking System on MCU** |
| | ○ Deployed an ultra-lightweight deep learning model (under 70KB) on an ESP32, achieving real-time face tracking with a frame rate of 4 FPS, specifically designed for low-power MCUs. |
| 2024–Present | **On-device Leaf Disease Detection** |
| | ○ Developed a plant disease detection model optimized for deployment on an MCU with a 120KB RAM footprint, enabling low-power, low-latency offline inference on resource-constrained hardware, contributing to sustainable AI solutions. |
| 2024–Present | **Disaster Surveillance Using Image Classification** |
| | ○ Integrated a low-power, low-RAM image classification model onto a drone system powered by an ESP32, designed for real-time, low-cost disaster surveillance in affected areas. |
| 2021–2022 | **Intrusion Detection on Edge Devices** |
| | ○ Designed an intrusion detection system using WiFi sensing and camera-based deep learning on edge devices for real-time monitoring. |
| | ○ Developed an acoustic surveillance system for environmental monitoring. |
| 2019–2020 | **Automatic Image Colorization** |
| | ○ Applied Generative Adversarial Networks (GANs) to colorize black-and-white images efficiently, optimizing the solution for edge devices with limited processing power. |

## Publications

1. Saha, Bidyut, et al. **"BandX: An intelligent IoT-band for human activity recognition based on TinyML."** Proceedings of the 24th International Conference on Distributed Computing and Networking. 2023.

2. Saha, Bidyut, et al. **"TinyML-Driven On-Device Personalized Human Activity Recognition and Auto-Deployment to Smart Bands."** Proceedings of the Third International Conference on AI-ML Systems. 2023. *[Best Research Paper Award]*

3. Saha, Bidyut, et al. **"From Wrist to World: Harnessing Wearable IMU Sensors and TinyML to Enable Smart Environment Interactions."** Proceedings of the Third International Conference on AI-ML Systems. 2023. *[Best Demo Paper Award]*

4. Saha, Bidyut, et al. **"Personalized Human Activity Recognition: Real-time On-device Training and Inference."** IEEE Consumer Electronics Magazine. 2024.

5. Samanta, Riya, Bidyut Saha, and Soumya K. Ghosh. **"TinyML-On-The-Fly: Real-Time Low-Power and Low-Cost MCU-Embedded On-Device Computer Vision for Aerial Image Classification."** 2024 IEEE Space, Aerospace and Defence Conference (SPACE). IEEE, 2024.

6  Saha, Bidyut, et al. **"TinyML-Powered Gesture Wizardry: Low-Cost, Low-Power Two-Stage CNN for Static Hand Gesture Classification on MCU in Appliance Control."** Proceedings of the Fourth International Conference on AI-ML Systems. 2023. *(Accepted)*

7  Saha, Bidyut, et al. **"LeafSense: A Portable, Low-Cost, Low-Power Plant Disease Diagnostic Device Using TinyML."** Proceedings of the Fourth International Conference on AI-ML Systems. 2023. *(Accepted)*

8  Saha, Bidyut, et al. **"TinyTNAS: GPU-Free, Time-Bound, Hardware-Aware Neural Architecture Search for TinyML Time Series Classification."** arXiv preprint arXiv:2408.16535. 2024.

9  Saha, Bidyut, et al. **"Optimizing TinyML: The Impact of Reduced Data Acquisition Rates for Time Series Classification on Microcontrollers."** arXiv preprint arXiv:2409.10942. 2024.

10  Saha, Bidyut, et al. **"Towards Sustainable Personalized On-Device Human Activity Recognition with TinyML and Cloud-Enabled Auto Deployment."** arXiv preprint arXiv:2409.00093. 2024.

11  Samanta, Riya, et al. **"CTG-KrEW: Generating Synthetic Structured Contextually Correlated Content by Conditional Tabular GAN with K-Means Clustering and Efficient Word Embedding."** arXiv preprint arXiv:2409.01628. 2024.

## Patents & Tools

1  **Wearable Gesture Recognition System for Appliance Control** (Filed: Indian Patent, May 2024, Application No: 202431037176).

2  **TinyTNAS**: GPU-Free, Time-Bound, Hardware-Aware Neural Architecture Search for TinyML Time Series Classification. https://github.com/BidyutSaha/TinyTNAS.

## Technical Skills

| | |
|---|---|
| **Embedded AI & TinyML** | Deploying ML models on microcontrollers (MCUs) for real-time, low-power AI solutions using TinyML and TensorFlow Lite. |
| **Model Compression & Optimization** | Expertise in pruning neural networks for efficient deployment on resource-constrained devices without compromising accuracy. |
| **Neural Architecture Search (NAS)** | Conducting NAS optimized for CPU-based systems in embedded environments, eliminating GPU dependency. |
| **Custom PCB Design** | Designing custom PCBs for IoT applications, integrating sensors for AI-powered systems. |

| | |
|---|---|
| **Edge AI & IoT** | Real-time analytics and edge computing on low-power platforms such as ESP32 and Raspberry Pi. |
| **Full-stack Development** | Comprehensive knowledge of both front-end and back-end development for IoT systems. |
| **Mobile App Development** | Developing tools for data collection and user interaction via BLE and WiFi. |

## Professional Experience

| | |
|---|---|
| 2020–Present | **PhD Research Scholar**, Indian Institute of Technology, Kharagpur<br>Led research projects in **TinyML**, **low-power machine learning**, and **edge computing**, mentoring interns and B.Tech students. |
| 2016–2018 | **Full Stack Software Engineer**, Tata Consultancy Services, Kolkata<br>Developed desktop and web applications and enterprise software solutions. |

## Leadership & Mentoring

| | |
|---|---|
| Teaching Assistant | NPTEL Cloud Computing, IIT Kharagpur |
| Mentorship | Mentored 5 interns and 2 B.Tech students on TinyML and IoT project development. |

## Demos

| | |
|---|---|
| **On-Device HAR** | On-Device Human Activity Recognition, `https://www.youtube.com/watch?v=CNJ4wyo7Dyo` |
| **Gesture Control** | Gesture Control with TinyML, `https://www.youtube.com/watch?v=_57USD7uBtk` |
| **TinyML in Computer Vision** | Computer Vision with TinyML, `https://drive.google.com/file/d/1blo3jk4ag8X9VhA5FBZuLmeCsWQ2HeRp/view?usp=sharing` |