Filippo Ferrandino

Technologies for Environmental Control and Safety in Automatic Take-Off, Landing and Taxiing

Tutor: Alessandro Cilardo   co-Tutor: Gabriella Gentile

Cycle: 39   Year:2

Candidate's information

- MSc degree: Computer Engineering at UNINA

- DIETI Research group/laboratory:SECLAB

- PhD start date: 1/11/2023

- Scholarship type: *DM 117/2023*

- Partner company: CIRA

- Periods in compan: to 1/9/2024

Summary of study activities

- Ad hoc PhD courses/ schools:
  - Design methodologies for digital circuits and systems oriented to FPGA, UNINA
  - High Performance and Quantum Computing , UNINA
  - AI @ The Deep Edge, ST
  - Safety Critical Systems for Railway Traffic Management, UNINA
  - Nextcomm, CESMA
  - CINI HPC Summer school, CINI
  - TAROT Summer school, UNINA
  - ACACES Summer school, Hipeac

- Conferences / events attended:
  - CIRA PhD Days

Research field of interest

This research is framed within the SESAR Strategic Research Agenda for the Digital European Sky

The agenda focuses on key research areas aimed at meeting the increasing demands of air transport while ensuring sustainability. Two key needs are particularly relevant to this work:

1. The development of new Air Traffic Management (ATM) technologies through SESAR projects to improve ATM performance.

2. Smart management of airport capacity to align it with air transport demands. Within this context, the research focuses on specific technologies to improve airport security.

Research area

Problem

- Design component the logic paradygm of Situational Awareness (SA) : Perception, Comprehension, Projection

- Reserach should eleaborate algorithms for :

  ❑ Perception (addressing obstacle detection)

  ❑ Comprehension (Understanding the object, its nature, and its behavior)

  ❑ Projection (Predicting what the object will do within the applicable lookahead for a specific use case) on a specific use case
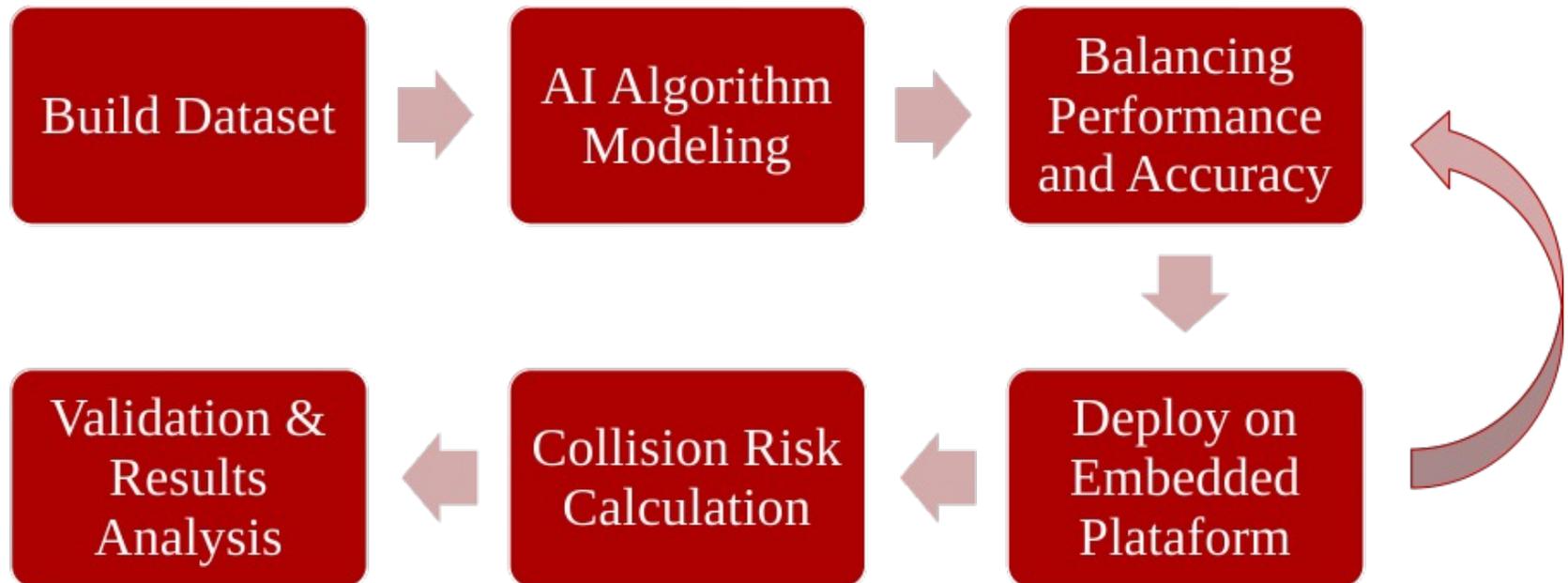
Research results

Solution

Object detection over airport areas using YOLOv11 optimized for real-time execution on Jetson AGX Orin.

- Classification of detected ground movements into five macro-categories (Bird, Person, Plane, Vehicle, FOD) with associated risk coefficients.

- Estimation of object position, direction, and velocity using stereoscopic vision and tracking algorithms (ByteTrack, BoTSORT) to predict potential hazards.

Designed system provides a real-time hazard map to support decision-making in autonomous ground operations.

IMPLEMENTATION

Research results

Realizate custom LUT-PUF

- To ensure the authenticity and integrity of the hardware platform, a Physical Unclonable Function (PUF) was implemented by configuring the FPGA LUTs.

- The main PUF evaluation metrics were analyzed. The updated implementation achieved a significant improvement in inter-device uniqueness, increasing from **0.11 to 0.45**, which is closer to the ideal value (0.5). This enhancement, however, comes with a minor trade-off in the remaining performance parameters.

Metrics*	Test/Ideal
Reliability	0.983/1
Uniformity	0,51/0.5
Bit aliasing	0,53/0.5
Uniqueness	0.46/0.5
Area	1 Lut for bit response

itee PhD
information technology
electrical engineering

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Research results

Scalable AI for Edge Devices

I continue to explore optimal solutions for running AI on embedded systems. GPU-based devices have proven highly effective, combining scalability, energy efficiency, and flexibility to scale toward high-performance or cloud systems when needed.
For ultra-low-power applications, AI models on microcontrollers or sensors offer excellent efficiency, though with some trade-offs in performance.
Recently, devices such as the **STM32N6**, featuring **embedded NPUs**, have shown promising results, enabling **computer vision** workloads with only a few watts of power consumption.
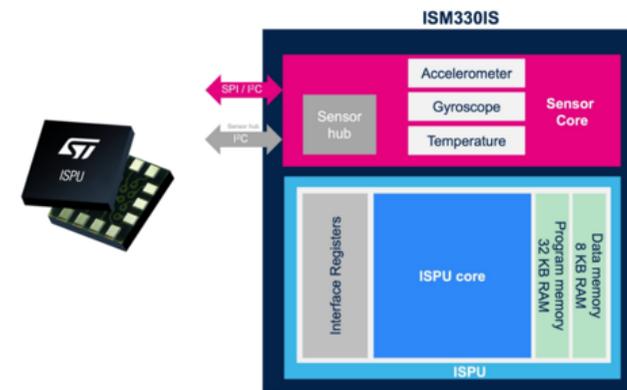
Research results
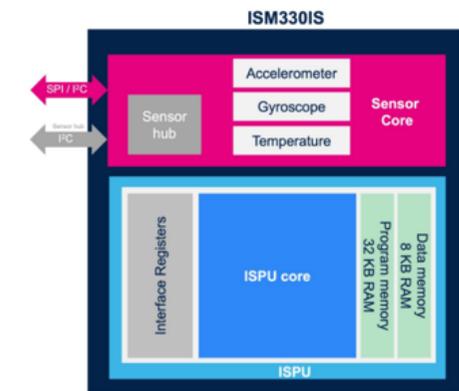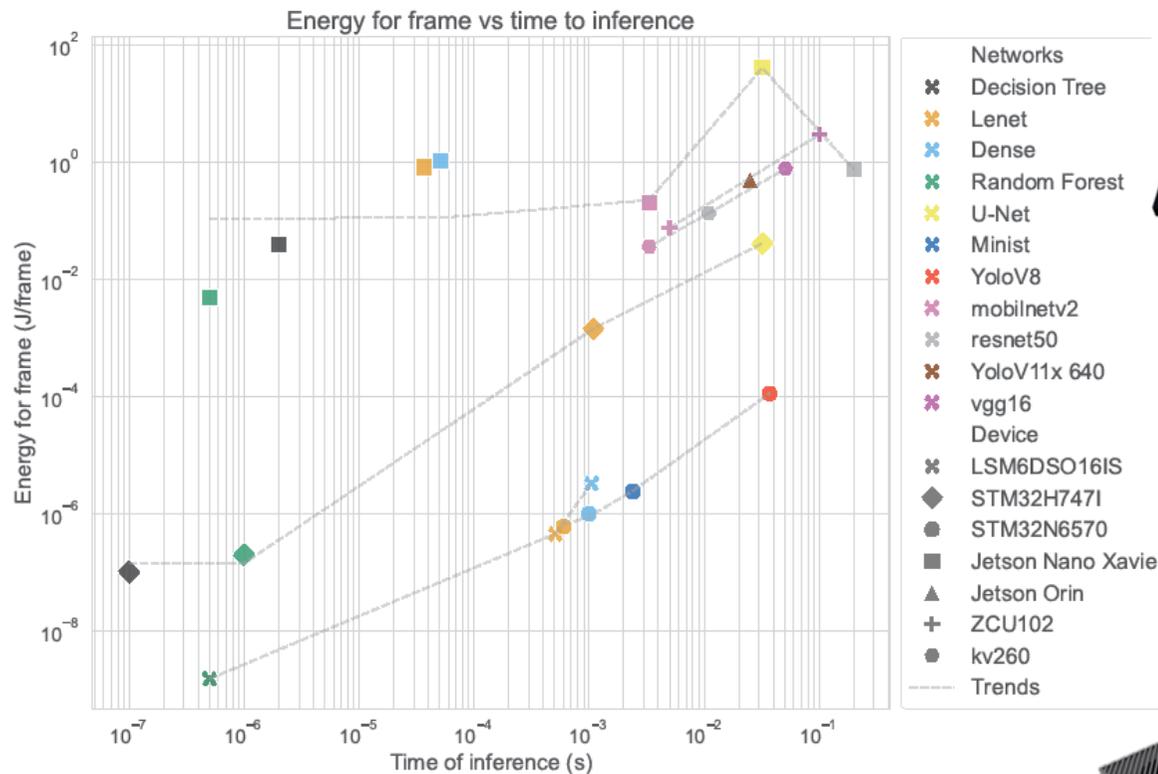
Scalable AI for Edge Devices(*)

*Salvatore Bramante, **Filippo Ferrandino**, Alessandro Cilardo
Energy-Efficient AI Deployments at the Urban Edge: Lessons from Hardware Profiling

Research products

[P2]	**Filippo Ferrandino**, Daniele Lombardi, Alessandro Cilardo A novel ultra-compact FPGA-based Physical Unclonable Function *IEEE Transactions on Computers* - **Q1 Journal** [Submitted on 6/2025]
[P3]	Salvatore Bramante, **Filippo Ferrandino**, Alessandro Cilardo Energy-Efficient AI Deployments at the Urban Edge: Lessons from Hardware Profiling **Smart Cities - Q1 Journal** <u>In rewriting</u>
[P4]	Mario Barbareschi, Salvatore Barone, **Filippo Ferrandino** Optimizing Accuracy-Loss in Approximate Neural Network via GPU-Driven Bit-Width Emulation **Transactions on Computer-Aided Design of Integrated Circuits and Systems - Q1 Journal** [Submitted on 10/2025]
[P5]	**Filippo Ferrandino**, Angelo Manco, Gabriella Gentile, Alessandro Cilardo "Enhancing Situational Awareness in the Airport Environment: A Use Case Approach" **In writing**

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