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PES UNIVERSITY

TRIVERSE Ideathon 2025

Round 2 : Detailed Presentation

Idea Title :	**Smart Adaptive Machinery -** Neuromorphic Edge for Real-Time Mechanical Automation
Team Name :	**Smart Adaptive Machinery**

Name of Ideators	Roll No.	Batch
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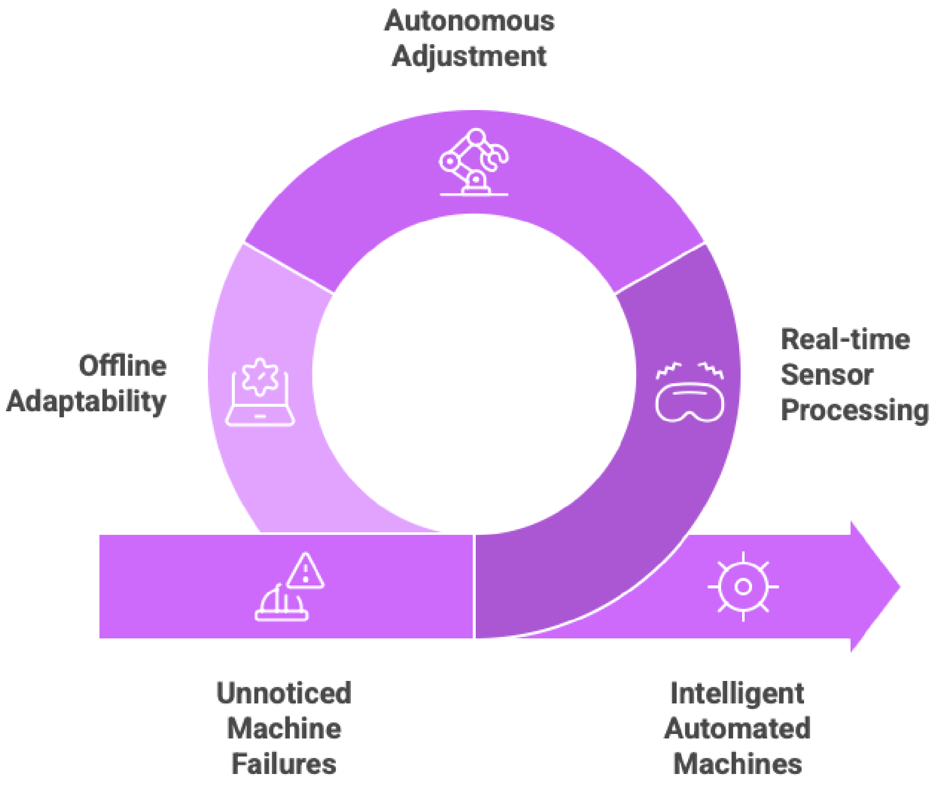
Background and Problem Statement

Kindly provide the background of the Idea, the underlying problem statement. Need for a solution etc.



Industrial machines face issues like vibration, wear, misalignment, and load fluctuations that often go unnoticed until sudden failure, causing costly downtime, safety risks, and high maintenance.

Imagine a factory where machines think for themselves. Our system monitors mechanical behavior, detects anomalies instantly, and adjusts autonomously. It's a fusion of mechanical engineering and next-gen AI, creating truly intelligent automation

There is a need for an on-device intelligence system capable of real-time sensor processing, instant decision-making, and offline adaptability—operating at extremely low power compared to traditional neural networks. Such a system must enable machines to locally interpret vibration and mechanical signatures, communicate machine-to-machine, and function entirely on the device without cloud dependency.

Deep Dive into the Problem Statement

Kindly provide a detailed view of the problem statement, its issues and challenges etc

Industrial machines such as motors, conveyor belts, and robotic arms experience gradual issues like vibration, wear, misalignment, and load variations that are hard to detect early. These hidden changes often lead to sudden failures, causing downtime, quality drops, and safety risks.

Current monitoring methods rely on manual inspection or cloud-based IoT, both of which fail to provide real-time responsiveness. Manual checks miss early abnormalities, while cloud systems add latency, depend on constant connectivity, and consume high power. As a result, machines cannot sense their own condition or react instantly.

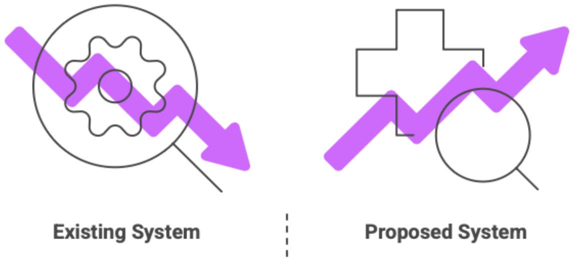
Conventional AI models also fall short because they require high computational resources and cloud processing, making them unsuitable for embedded industrial environments. This prevents machines from becoming proactive and self-correcting.

Therefore, industries need an ultra-low-power, on-device intelligence system capable of real-time sensor processing, instant decision-making, offline adaptability, and machine-to-machine communication. Neuromorphic edge AI enables this by performing spike-based sensing and local learning, enabling machines to detect anomalies early and operate autonomously.

Existing Vs Proposed Solution

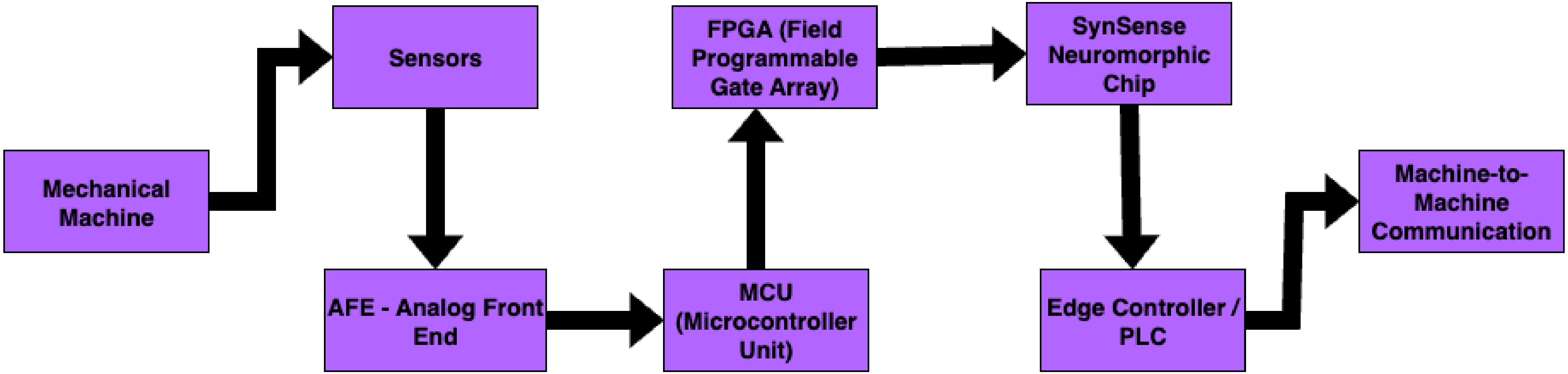
Kindly provide a comparison of Existing Solution Vs Proposed Solution

Existing Industrial Solutions	Proposed Neuromorphic Edge Solutions
Detects issues only after visible symptoms or complete failure	Detects micro-vibrations, early wear, and subtle anomalies instantly
Slow response time; affected by network delays and processing time	Instant response; microsecond-level spike-based decisions
Expensive; requires cloud setup, server maintenance, large infrastructure	Simple edge deployment with compact hardware and local intelligence
Machines operate independently with no coordination	Machine-to-machine communication enables coordinated actions
High power usage from continuous data transmission	Ultra-low power consumption through event-driven neuromorphic chips



Proposed Architecture of AI/ML and Gen AI Solution

Kindly describe the detailed Architecture of the proposed solution Clearly highlighting the AI element



Proposed Implementation of AI/ML and Gen AI Solution

Kindly describe the detailed Implementation Approach

Sensor Layer: Industrial sensors (accelerometers, IMUs, load cells, DVS) continuously capture vibration, motion, and load signals from the machine.

Analog Front End (AFE): Filters noise, amplifies signals, extracts envelopes, and generates clean threshold-based events for digital processing.

MCU Processing: Reads conditioned signals, performs basic preprocessing (RMS/peaks), converts values into spike patterns, and manages configuration.

FPGA Spike Engine: Generates precise, high-speed spike streams, formats AER packets, and supports parallel processing across multiple sensor channels.

SynSense Neuromorphic Chip: Runs SNN models to analyze spike patterns in real time, detect anomalies, and make ultra-low-power on-device decisions.

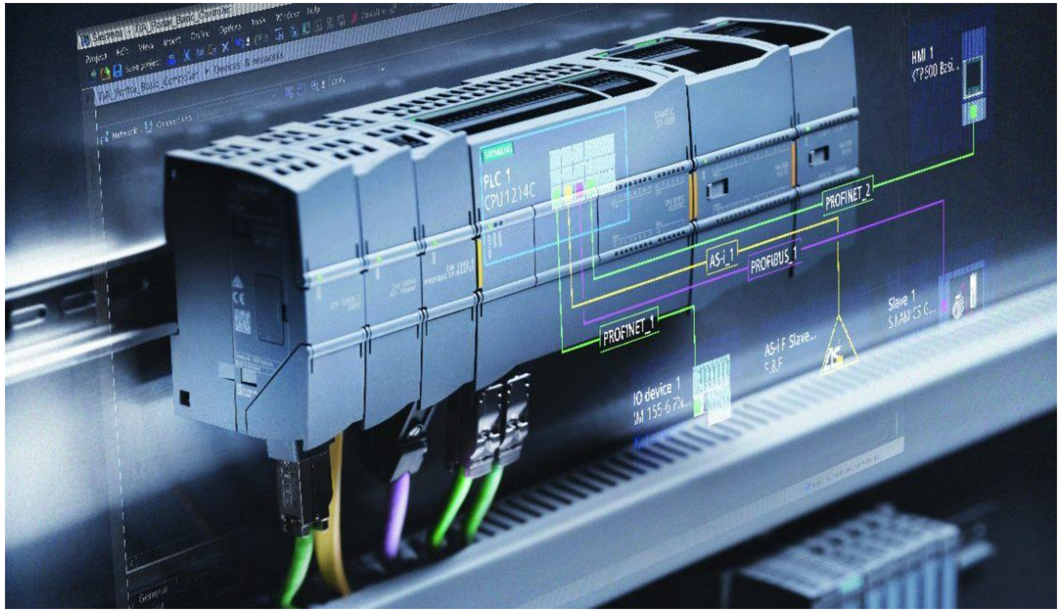
Edge Controller + M2M Network: Executes corrective machine actions (speed adjust, stop, alert) and shares status across machines via CAN/RS485/EtherCAT.

Proposed Technology Stack (Optional)

Kindly describe the proposed Technology/Tools Stake for the ideas implementation. (Optional but good to have)

- AFE - OPA333 / OPA376, AD8606, TLV7031 /MCP6561
- MCU - STM32L4 (STM32L476 / STM32L496)
- Neuromorphic Chip - SynSense Speck DVS : Ultra-low-power SNN processor for real-time anomaly detection at the edge.

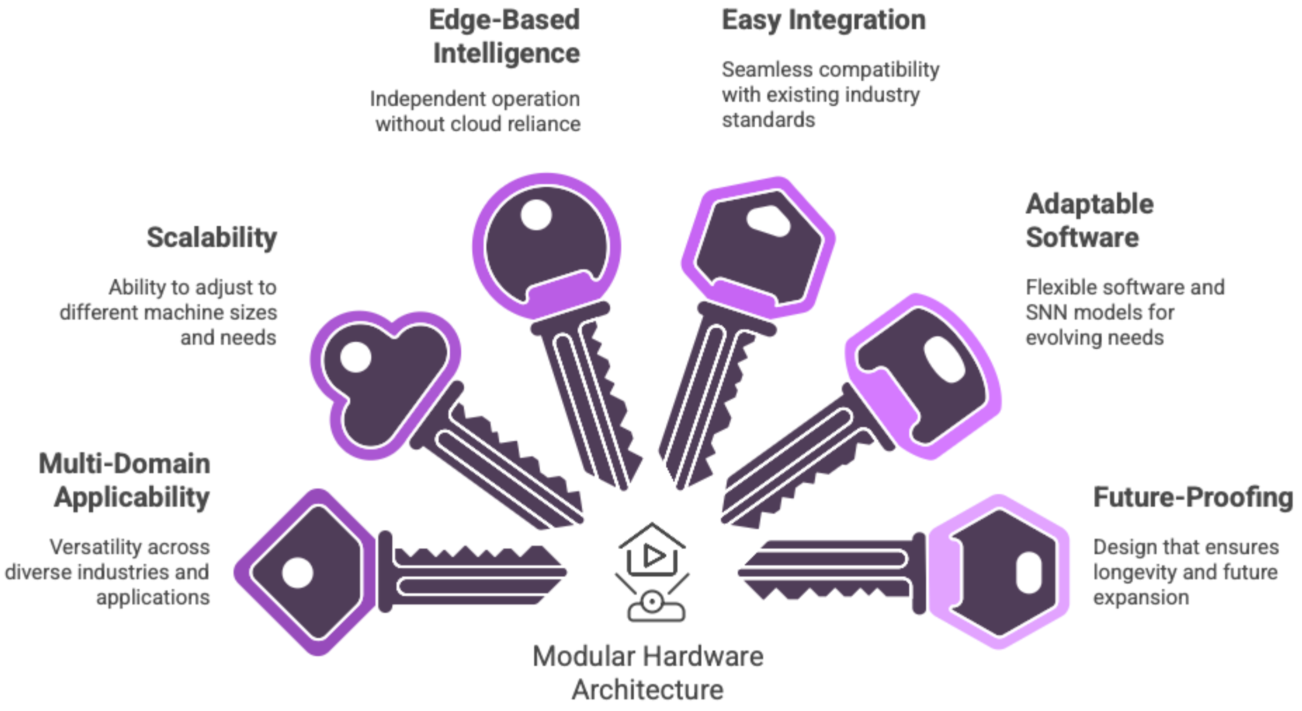
- FPGA - Lattice iCE40 UltraPlus
- PLC - Siemens S7-1200



Reusability/Scalability of the idea

Kindly describe your idea with respect to “Reusability/Scalability” across different domains

- Modular Hardware Architecture
- Multi-Domain Applicability
- Scalable Across Machine Sizes
- Edge-Based Intelligence (No Cloud Dependency)
- Easy Integration with Existing Industrv Protocols
- Adaptable Software / SNN Models
- Future-Proof & Expandable



Impact/Benefit of the idea implementation

Please describe the commercial aspects in terms of Revenue generation capability of this idea , through simple calculations (if any):

1. Hardware Sales (Primary Revenue)
Neuromorphic monitoring node selling price: ₹4,000 – ₹6,000 per machine
A typical medium factory (30–50 machines):
≈ ₹2–3 lakh revenue per installation

2. Annual Maintenance & Software Updates
Device support + SNN model updates: ₹300 – ₹600 per device/year
Example (150 deployed devices):
≈ ₹45,000 – ₹90,000 recurring yearly revenue

3. Optional Edge AI Dashboard Subscription
Plant-wide analytics: ₹1,000 – ₹3,000 per factory/month
Example (3 factories):
≈ ₹36,000 – ₹1,08,000 per year

4. OEM Licensing (High-Value Opportunity)
Licensing for embedding our module in equipment: ₹150 – ₹400 per unit
Example (2,000 units shipped by a small OEM):
≈ ₹3–8 lakh annual licensing revenue

Total:
With 3–4 factories + 1 small OEM partner:
≈ ₹14–15 lakh/year