

Abstract of the Problem (Max. 1000 words) *

Digital fabrication and smart manufacturing infrastructures are critical enablers of hardware innovation, prototyping, and small-batch production. However, these environments operate with limited visibility into machine utilization, downtime, energy consumption, and equipment health. Most fabrication machines—such as 3D printers, scanners, and laser cutters—lack native digital interfaces for monitoring and predictive maintenance.

Existing Industry 4.0 solutions are largely controller-dependent, invasive, and cost-intensive, making them impractical for retrofit deployment in mixed-generation fabrication environments commonly found in MSMEs, academic institutions, and prototyping centers.

This project proposes the development of a machine-agnostic, non-intrusive edge intelligence system that captures electrical and operational signal signatures to infer machine states, detect anomalies, and enable predictive maintenance—without accessing machine controllers or modifying existing equipment. The solution processes data locally at the edge, ensuring low latency, data privacy, and deployment flexibility.

The system will be validated under real fabrication workloads across multiple machine categories, demonstrating improvements in utilization efficiency, reduced unplanned downtime, and actionable operational insights. By enabling scalable retrofit intelligence, this project bridges the gap between digital fabrication infrastructure and smart manufacturing intelligence, directly supporting the digital transformation of MSMEs, academic labs, and innovation centers in Tamil Nadu.