Industry
Manufacturing

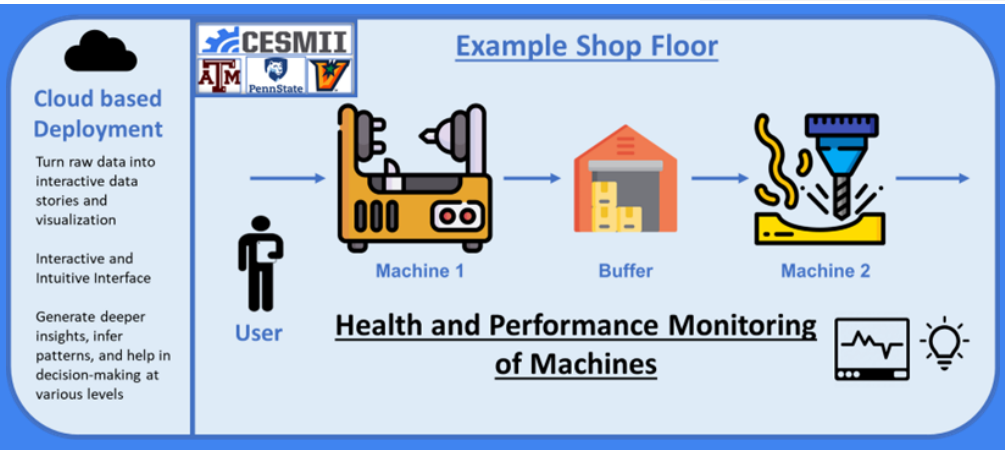
Applications
Sensing
Data Modeling
Data Analytics

Solutions
Energy Efficiency

CESMII
THE SMART MANUFACTURING INSTITUTE

PROJECT CASE STUDY

Self-Powered Sensing and Data Science for Smart Manufacturing



PROJECT LEAD

Penn State

PROJECT TEAM

Texas A&M, University of Texas – Rio Grande Valley

PROJECT OBJECTIVE

The goal of this project is to develop two key technologies: self-powered smart sensor wrapper schema, and advanced data analytics methods. These technologies will then be implemented to integrate a legacy machine into the smart manufacturing platform.

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Self-Powered Sensors and Machine Learning Drive Manufacturing Productivity

BENEFITS TO OUR NATION

By reducing equipment downtime, manufacturers can maximize operational efficiency, ensure timely delivery of products, and increase customer satisfaction. Optimizing the utilization of existing equipment allows manufacturers to achieve higher profitability without taking on higher costs of adding new production infrastructure. According to the National Institute of Standards and Technology (NIST), manufacturing comprised 11.3% ($2.7 trillion) of US 2022 GDP. Any process improvements adopted by manufacturers would have a profound, positive effect on the overall US economy.

BENEFITS TO INDUSTRY

Improved productivity translates to increased output with the same or fewer resources, resulting in improved efficiency and cost-effectiveness. This increased productivity leads to improved competitiveness, allowing manufacturers to capture larger market share and expand their customer base. Moreover, higher productivity levels enable manufacturers to capitalize on economies of scale, driving down production costs and improving profit margins.

PROJECT DESCRIPTION

TECHNICAL APPROACH

- Formal specification of a sensor wrapper to identify sensors and actuators needed to collect legacy machine information.
- Development of novel self-powered sensors, cloud and edge-based communication and computation architecture, sensor-based models and algorithms for real-time control and scheduling.
- Development of a test bed with advanced real-time sensing using energy-harvesting sensors, analytics, and optimization capabilities to demonstrate improved energy efficiency.

ACCOMPLISHMENTS

- Developed a sensor – fault mapping dictionary (for the first time in the literature for Smart Manufacturing).
- Developed a discrete event maintenance scheduling application: Simantha.
- Developed a scheduling application with reinforcement learning for High-Mix-Low-Volume production.
- Developed an analytics application with a visualization dash-board for grinding processes based on real-time signal feature extraction and a complex neural network learning paradigm.
- Developed a smart sensor-wrapper for hybrid machine monitoring.
- Implemented 4 software applications (with dashboards) and integrated them with the Smart Manufacturing Innovation Platform (SMIP) at Texas A&M.

DELIVERABLES

- Delivered Dashboard for Machine Health Monitoring and Production Scheduling (Powered by Reinforcement Machine Learning)
- Delivered Production Equipment Data Classification Tool Using Distributed Random Forest with Edge-Cloud Partitioning
- Delivered Manufacturing Productivity Dashboard, Enabling Operators to Simulate and Visualize Productivity Status and Machine Health, based on M. Hoffman's Simantha Simulator
- Delivered Smart Surface Grinding Application powered by explainable AI (XAI) vibration sensing

REUSABLE OUTCOMES / SM MARKETPLACE

- Sensor information models
- Real-time control and scheduling algorithms
- Dynamic machine service and task scheduling dashboard
- Self-powered sensor models

RESULTS

↓ 10%

Estimated 10% reduction in equipment downtime when a manufacturer implements the smart sensing and scheduling technology demonstrated in this project.

PROJECT DETAIL
Budget Period: BP2-BP5
Submission Date: 2/24/2023
Sub-Award (contract) Number: 4550 G YA100
SOPO: 2314

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