Smart Manufacturing modular solutions from CMTI

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- Digital MES integrated with Industry 4.0 module for Batch / discrete Manufacturing
- Machine Tool Condition Monitoring Module
- Intelligent Multi-sensor Data acquisition and analysis system
- Machine to Cloud Connecting EDGE Device- M2C-EDGE-LINK
- IIoT Unified Control Panel for Smart Foundry.
- Integrated Smart Foundry.
- Smart Tool Holder.
- Smart AI enabled Automated Weld Defect Detection System

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Technology for Converting Legacy Machines to Smart

Introduction

Legacy machines in manufacturing lack real-time monitoring, leading to inefficiencies and unplanned downtimes. This project aims to retrofit these machines with Industrial IoT (IIoT) solutions for enhanced performance and predictive maintenance.

Solution Overview

A Data Acquisition (DAQ) system collects key machine parameters via sensors and transmits data to the cloud using a Wifi-enabled edge device. A real-time dashboard provides insights into machine health and efficiency.

Key Features

- Machine Thermal Behavior – Monitors overheating trends for early fault detection.
- Spindle Health Monitoring – Tracks vibration data for predictive maintenance.
- Energy Monitoring – Analyses power consumption to optimize efficiency.
- Part Quality Check – Uses a real-time vision system for defect detection.

Figure 1: Solution User Dashboard

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Energy Monitoring Solutions for MSME

Introduction

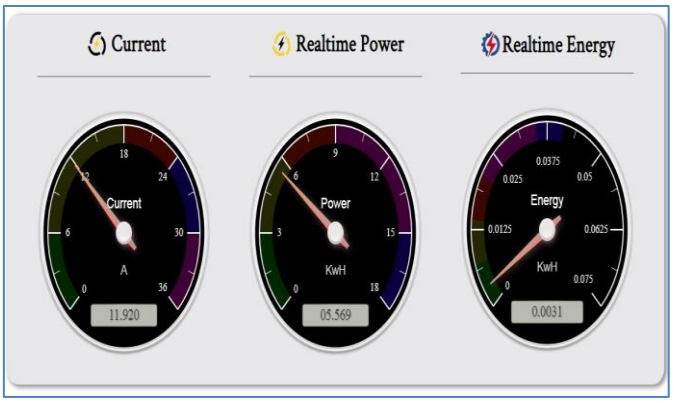
Small-scale industries (MSMEs) often lack affordable solutions to monitor energy consumption and machine productivity. This project aims to develop a low-cost Energy Monitoring IIoT Solution that enables real-time tracking and reporting of machine status and energy usage.

Solution Overview

The system integrates IIoT-based sensors with a user-specific dashboard to provide real-time monitoring. Automated daily reports are sent via email to help proprietors optimize energy consumption and improve productivity.

Key Features

- Machine Productivity & Status Monitoring – Tracks operational efficiency.
- Factory Energy Utilization – Analyses power consumption trends.
- Automated Daily Reports – Sends machine and energy reports via email.
- Cost-Effective Solution – Designed for small-scale industries or single-machine setups.



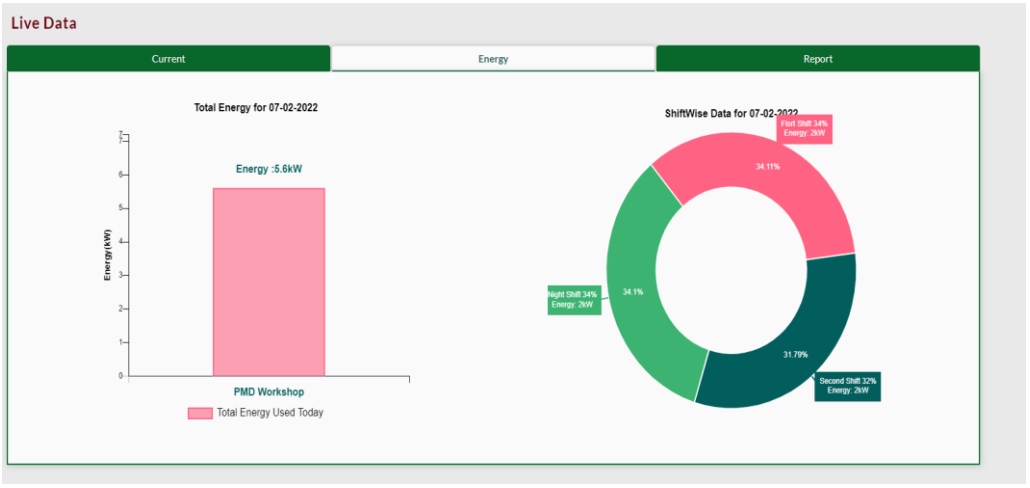


Figure 1: Dashboard view of energy solution.

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Low-Cost Energy Monitoring IIOT Solution for Smart Factory

Introduction

Small and medium-sized enterprises (MSMEs) often struggle with real-time monitoring of energy usage and machine productivity. This project focuses on developing a low-cost IIoT-based Energy Monitoring Solution for smart factories, enabling proprietors to track machine status and shop floor productivity through a user-friendly dashboard and automated email reports.

Solution Overview

The system integrates IoT-enabled sensors to capture machine productivity and energy consumption data. This information is processed and displayed on a real-time dashboard, with automated daily reports sent via email for enhanced decision-making.

Key Features

- Productivity & Machine Status Monitoring –Real-time insights into machines.
- Factory Energy Utilization – Tracks power consumption across the shop floor.
- Automated Daily Reports – Sends productivity and energy usage summary emails.

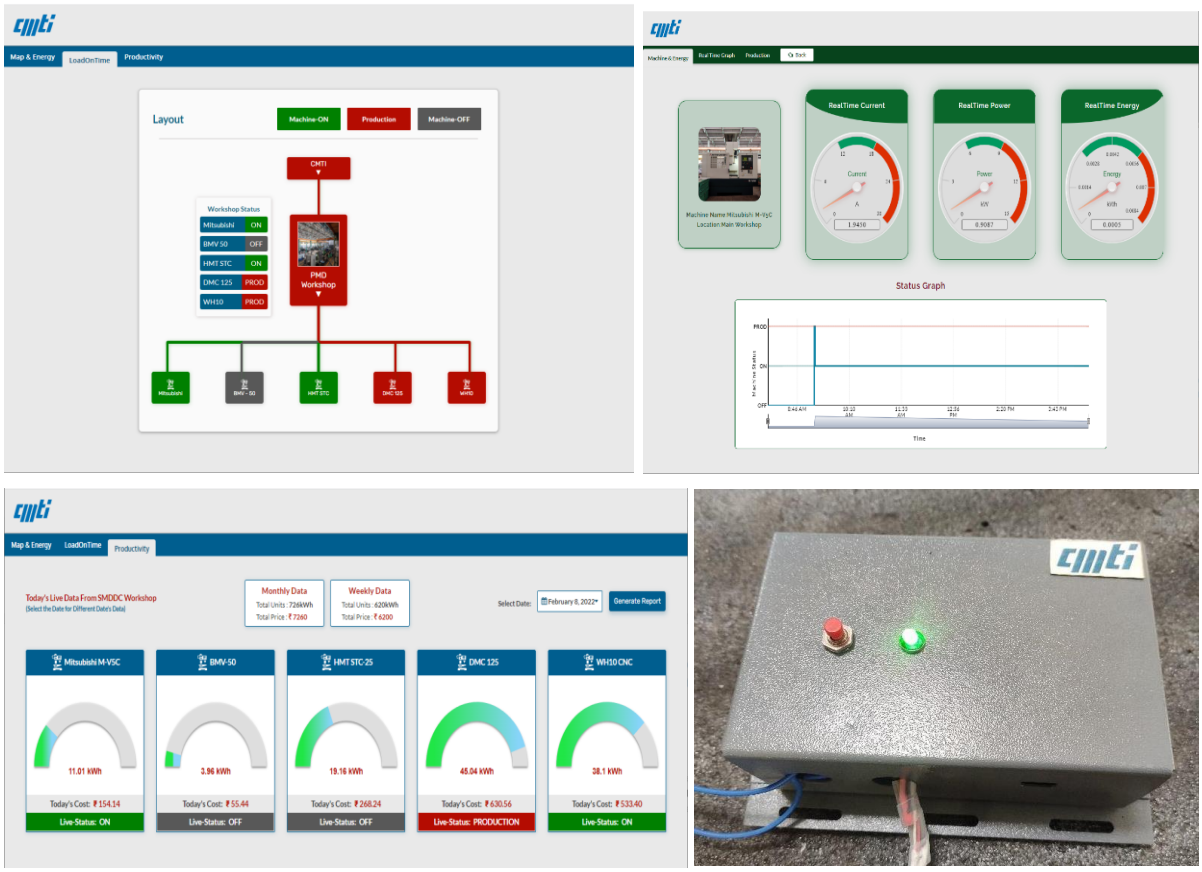

Figure 1: User-Dashboard view of the solution and Edge-Gateway module.

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Smart Energy Meter for Industry Asset Monitoring

Introduction

Traditional energy monitoring lacks real-time insights and historical data analysis, leading to inefficient energy utilization. This project focuses on developing a Smart Energy Monitoring Solution that provides 24/7 real-time energy data for improved decision-making.

Solution Overview

A smart energy meter continuously measures current, power, and energy consumption. The collected data is transmitted to a cloud database, where it is analysed and displayed on a web-based dashboard with historical data insights.

Key Features

- Real-Time Energy, Power, and Current– Provides factory-wide visibility.
- Cloud-Based Web Dashboard – Enables remote access to live and historical energy data.
- Historical Data Analytics – Helps identify trends, inefficiencies, and cost-savings.

Figure 1: User-Dashboard view of the solution and Smart Energy Meter.

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Module for Remote Monitoring for CNC Machines using M2M Connectivity

Introduction

CNC machines require continuous monitoring to ensure optimal performance and minimize downtime. This project develops a Remote Monitoring System using Machine-to-Machine (M2M) connectivity, enabling real-time insights for operators, maintenance engineers, and factory supervisors.

Solution Overview

The system integrates M2M communication to collect CNC machine data, detect faults, and enable remote diagnostics. A cloud-based dashboard provides real-time machine performance, alarms, and maintenance insights for different user roles.

Key Features

- Comprehensive Machine Monitoring – Allows operators to track CNC machine status in real time.
- Machine Alarms & Diagnostics – Enables remote troubleshooting by maintenance engineers.
- Factory-Wide Monitoring – Provides supervisors with factory-level insights for decision-making.

Figure 1: User-Dashboard for machine monitoring with Machine-to-Machine connectivity.

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Process Monitoring Module for CMC metal cutting machine, using OPC UA

Introduction

Effective process monitoring is essential to ensure machining accuracy and efficiency. This Process Monitoring Module enables real-time tracking of machining cycles, providing automated pass/fail results and adaptive control, making it easier for beginners to operate CNC machines efficiently.

Solution Overview

The module integrates with CNC machines to analyse machining cycles, dynamically adjust process limits, and provide real-time feedback. This helps operators, including beginners, ensure quality without extensive manual intervention.

Key Features

- Adaptive Limits – Automatically adjusts based on actual machining cycles.
- Pass/Fail Information – Instantly determines whether the process meets quality standards.
- Real-Time Cycle Updates – Continuously monitors and updates process status.

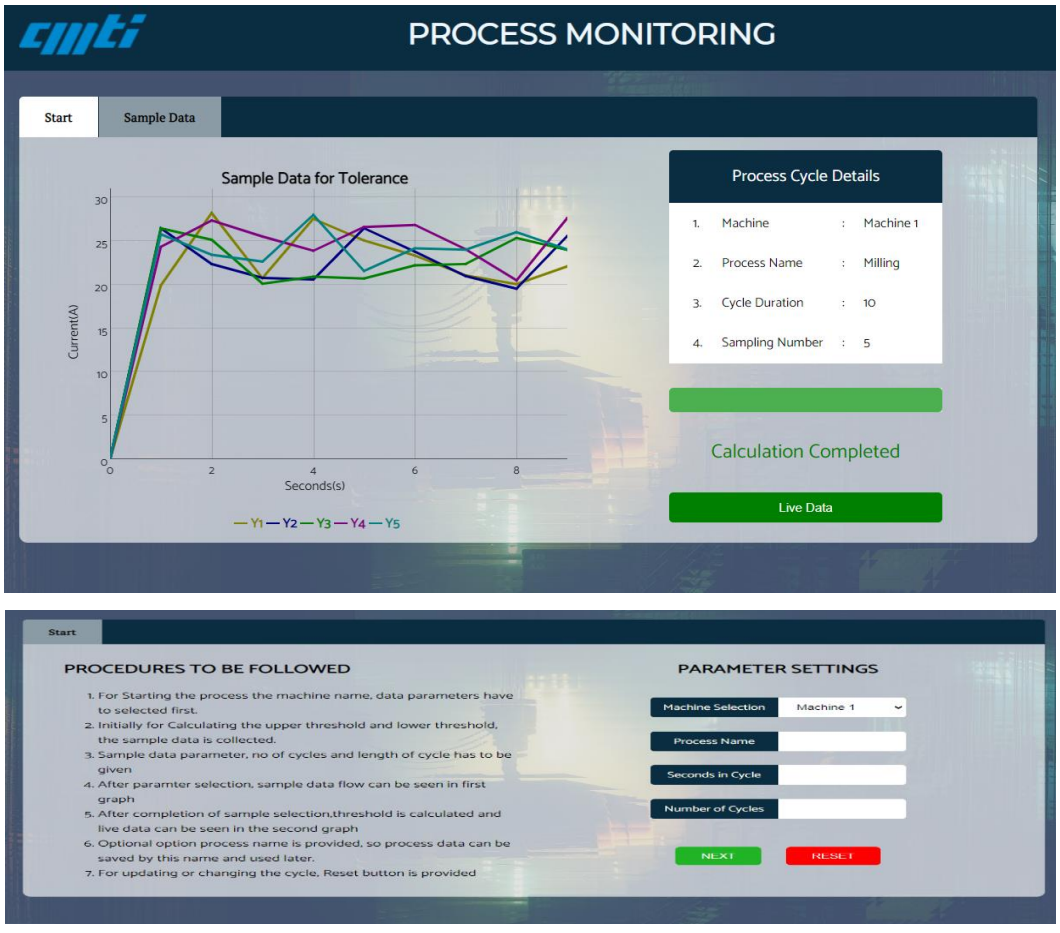

Figure 1: User-Dashboard for Process Monitoring Module using OPC UA.

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IIoT-based OEE & OEE Losses Monitoring Software Solution for CNC Shopfloors

Introduction

Optimizing Overall Equipment Efficiency (OEE) is critical for improving production performance in manufacturing industries. This IIoT-based OEE monitoring solution enables real-time tracking of OEE losses, machine performance, and factory operations using M2M protocols, ensuring seamless data collection and visualization.

Solution Overview

The software provides OEE insights at both machine level and factory floor level, using the following key inputs:

- Availability & Quality Parameters – Real-time machine status and production quality.
- Planned Schedules & Maintenance – Tracks downtime and maintenance schedules.
- Factory Operational Hours – Monitors total working hours and efficiency.

Key Features

- Real-Time Machine Data – Operators, engineers, and supervisors get instant insights.
- Production Monitoring – Tracks OEE, utilization, performance, and downtime.
- Live Machine Data Visualization – Displays machine health, production status, and efficiency.

Figure 1: OEE-Dashboard for Shopfloor wise and Machine Based Analytics.

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IIoT Based Machine Maintenance Software Solution for CNC Shopfloors.

Introduction

To improve machine maintenance practices and reduce downtime, this system leverages real-time data insights to maintenance response time, reduce unexpected failures, and optimize machine performance with real-time alerts on critical parameters.

Key Features

- Real-Time Machine Monitoring – Captures machine performance data for predictive insights.
- Comprehensive Parameter Tracking – Monitors 17 machine health indicators.
- Custom Alerts & Notifications – Notifies maintenance teams of critical issues.

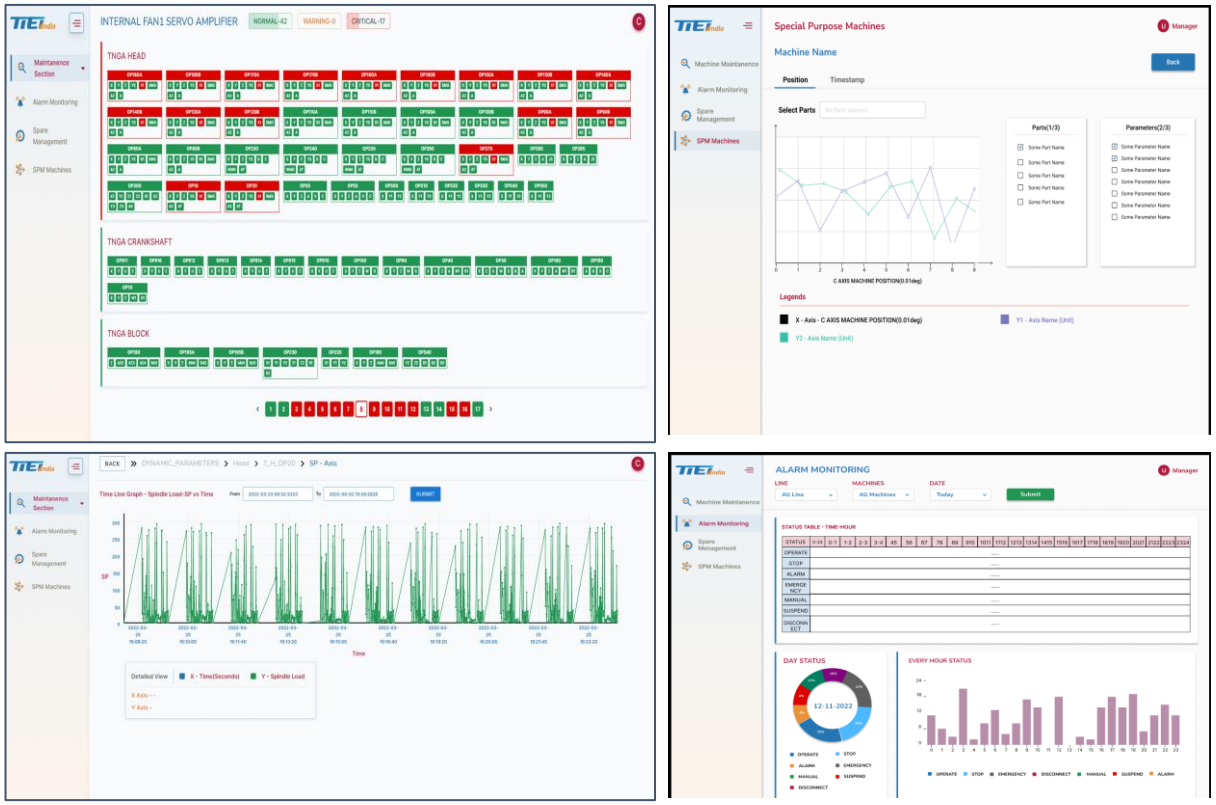

Figure 1: User-Dashboard for Plant-wise and Machine based parameter tracking.

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Data Acquisition and Machine Monitoring for Welding Machines Using Industry 4.0

Introduction

Traditional welding methodologies often lack real-time monitoring and efficiency tracking, leading to inconsistencies in quality and productivity. This project aims to modernize welding processes by integrating IIoT-based performance monitoring to enhance machine reliability, process visibility, and operational efficiency.

Solution Overview

The system enables real-time data acquisition and monitoring of welding machines through IIoT connectivity. Key components include:

- Voltage Transducers (VT) – Measure voltage fluctuations during welding operations.
- Hall Effect Current Sensors (HECS) – Monitor current variations for process stability.
- Programmable Logic Controller (PLC) – Central unit for data acquisition and machine control.

Key Features

- Real-Time Machine Monitoring – Captures voltage, current, and performance metrics.
- Process Quality Assurance – Ensures consistent weld penetration and material integrity.
- Custom Alerts & Notifications – Warns operators of anomalies in welding parameters.

Figure 1: IoT Panel for Machine based parameter tracking and Software Screens.

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Vision & AI-Based software solution for In-Process Solar Panel Inspection.

Introduction

This project leverages AI-driven vision inspection technology to automate defect detection in Monocrystalline and Polycrystalline Solar Panels (144 and 72 cells). The system provides real-time inspection, achieving a cycle time of 4 seconds per panel while identifying various defects.

Solution Overview

The system integrates AI-powered image processing with high-resolution vision cameras to detect and classify defects. Key inspections include:

- Microline Cracks
- Spider Cracks
- Tree Cracks
- Shunt Defects
- Soldering Defects
- Chipping

Captured images are processed using deep learning models, which analyse defect patterns, characterize defects based on length and area, and provide real-time marking on defective panels.

Key Features

- Defect Characterization – Classifies defects based on length and area.
- User-Defined Inspection Criteria – Adjustable settings for different panel types.
- Fast Inspection – 4-second cycle time per panel ensures high-speed processing.

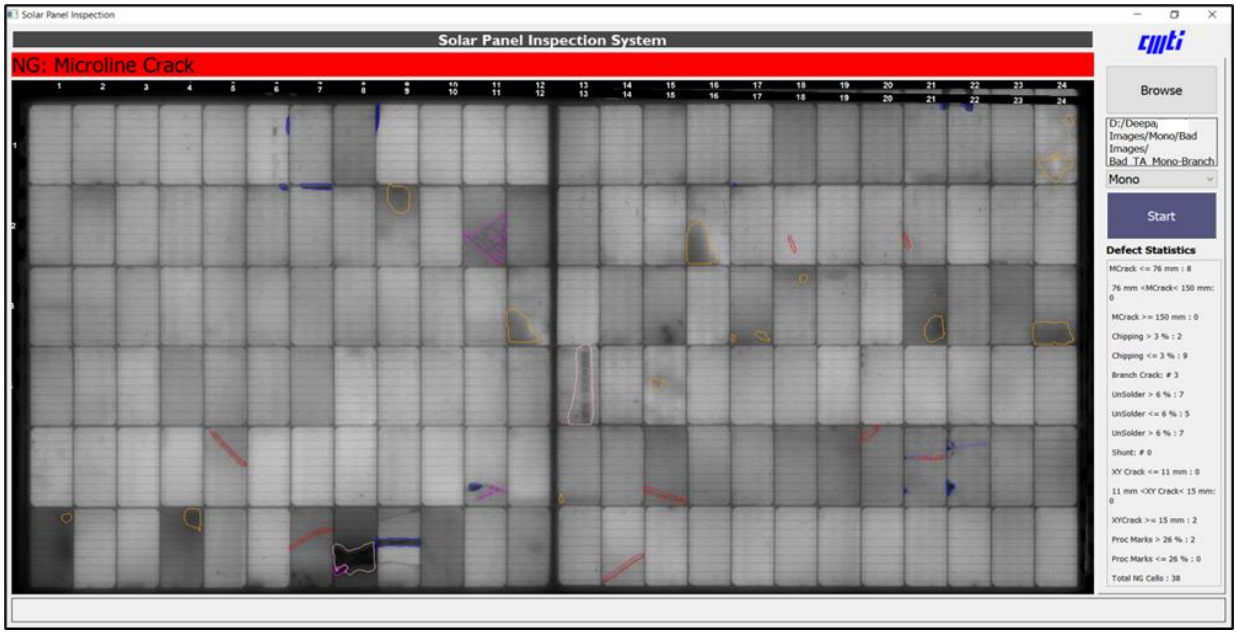

Figure 1: IoT Panel for Machine based parameter tracking and Software Screens.

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Autonomous Quality management Solution

Introduction

The Quality Solution is designed to enhance manufacturing process efficiency by automating inspections, improving data accuracy, and integrating real-time monitoring. The system enables ballooning of inspection drawings, direct measuring instrument connectivity, and automated report generation, ensuring compliance with ISO and industry standards.

Solution Overview

The Quality Solution software provides a centralized quality control system that streamlines inspection workflows, reduces human error, and ensures high product quality.

- Automated data collection from measuring instruments.
- Real-time quality monitoring for quick defect identification.
- Inspection step integration to standardize processes.
- Digital report generation for compliance and traceability.

Key Features

- Automated Inspection & Measurement – Auto-ballooning of inspection drawings, direct connectivity with measuring instruments, and automated data entry to eliminate manual errors.
- Real-Time Quality Monitoring – Live process inspection, SPC analysis, and instant deviation alerts to ensure proactive quality control.
- Intelligent Reporting & Analytics – Automated report generation, historical data analysis, and cloud integration for better decision-making.

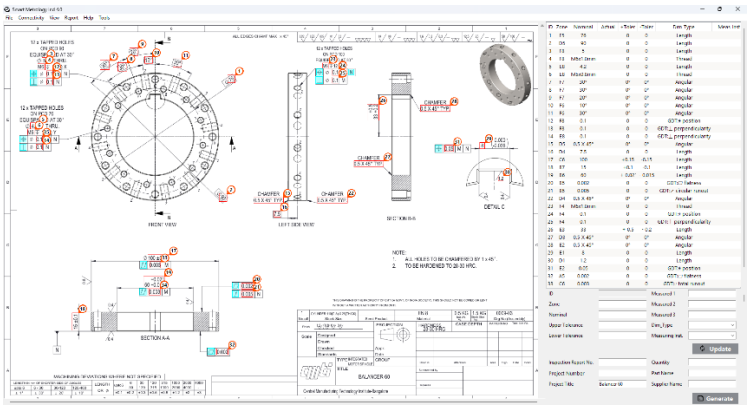

Figure 1: Quality Solution Screen for inspection and Auto-ballooning with Inspection Report generation.

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Digital MES integrated with Industry 4.0 module for batch / discrete manufacturing

Introduction

This pilot project focuses on developing a Manufacturing Execution System (MES) in alignment with Industry 4.0 principles. The goal is to create a digitized, real-time monitoring system that enhances efficiency across planning, production, and post-production phases.

Solution Overview

The MES software consist of multiple interconnected modules to optimize manufacturing workflows, ensuring:

- Real-time production monitoring to reduce machine downtime. Increase machine utilization with real-time production tracking and active status of machine OEE.
- Streamlined traceability from raw materials to finished products.

Key Features

- **Pre-Production Modules**

Digital Routing Charts – Standardized process mapping.
Manufacturing Process Plans – Optimized process documentation
Capacity Planning & Machine Scheduling – Efficient resource allocation.
Digital Inspection Documents – Real-time quality tracking.

- **Production Modules**

Production Monitoring – Live tracking of manufacturing activities.
OEE & Downtime Tracking – Maximized equipment efficiency.
Job Traceability – End-to-end product tracking.

- **Post-Production Modules**

Stage/Final Inspection Reports – Automated quality documentation.
Machine Maintenance Checklists – Preventive maintenance for reduced downtime.
Inventory Management – Smart tracking and stock optimization.
Document Management System – Digital records for compliance and audits.

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Machine Tool Condition Monitoring Module

Product Overview: The MTCM Edge Module is a powerful industrial control solution designed for real-time data collection and analysis. Powered by a Teensy 4.0 (ARM Cortex-M7, 600MHz CPU), it operates on 24V DC, 3A with 1984K Flash storage and built-in protection features. It includes 4 analogue inputs (16-bit ADC), 4 analogue outputs (12-bit), and 7 opto-isolated digital I/Os, supporting output voltages of 5V, 12V, and 24V. Connectivity options include Wi-Fi (2.4GHz), Ethernet (MODBUS TCP/IP), and RS485 (MODBUS RTU, half-duplex), along with an 8GB Micro SD slot.

Ideal for converting legacy machine smart, industrial automation, predictive maintenance, process control, and smart manufacturing, it enhances productivity, reduces costs, and improves connectivity. Its scalable, energy-efficient design enables cloud-based analytics, empowering industries with better decision-making. Housed in IP54 aluminium, it withstands 0–75°C and 10–90% RH humidity, ensuring reliable and efficient performance across diverse applications.

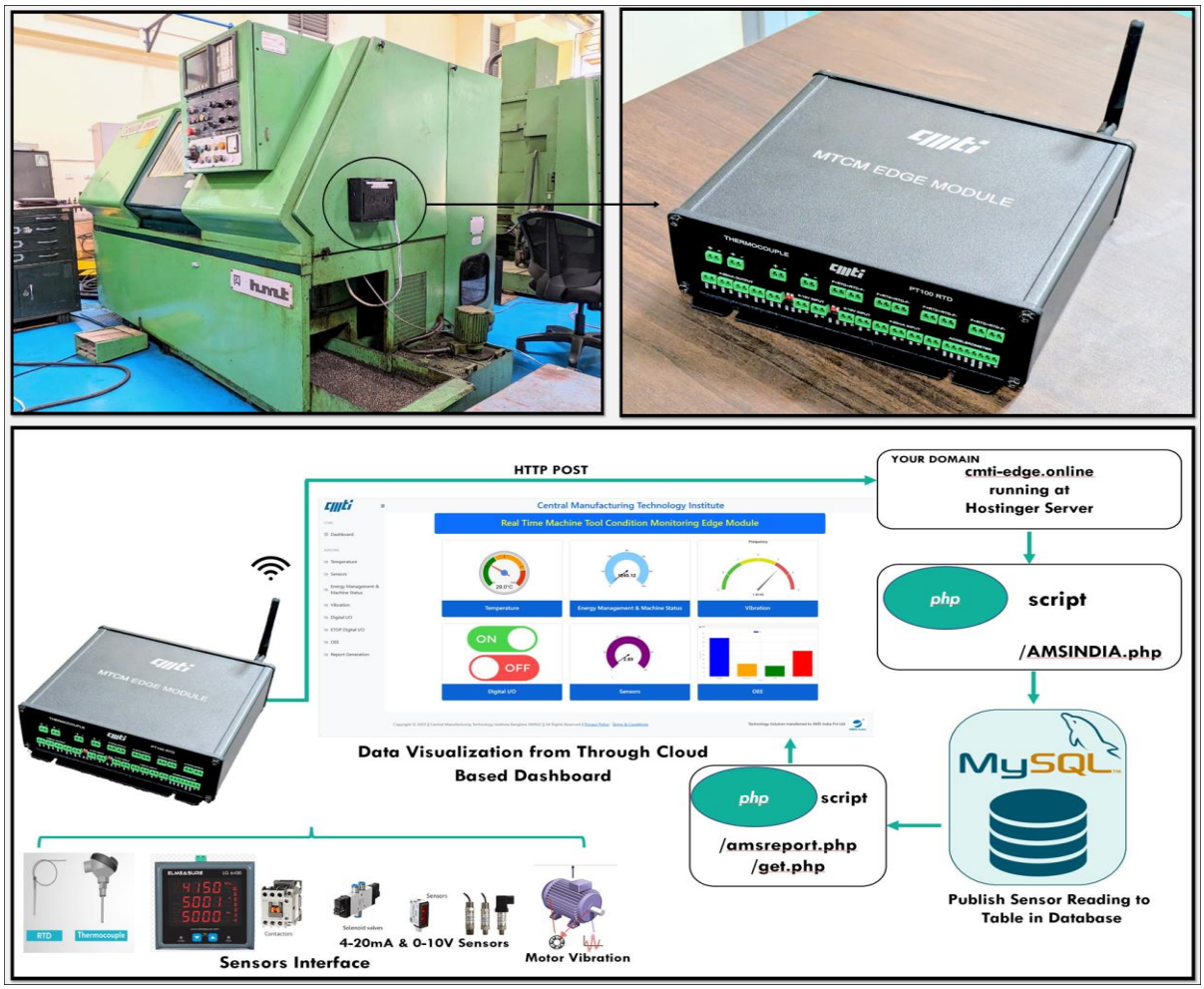

Figure 1: Tool Condition Monitoring Edge module and Solution Work-Flow.

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Intelligent Multi-sensor Data acquisition and analysis system (Intellipod)

Product Overview: The Intellipod is an advanced industrial device designed for machinery vibration monitoring, predictive maintenance, and process control with PLC functionality**.** It supports multi-sensor connectivity**,** including IEPE vibration sensors, temperature sensors, and digital/analogue inputs**,** with 10 analogue I/Os, 2 analogue outputs, and 32 programmable DI/DOs**.** Compliant with BS6 automotive data acquisition via CAN bus**,** it enables real-time signal capturing and AI/ML-based fault prediction**.** The cloud-based data analysis enhances fault detection and remote monitoring**,** improving equipment reliability and reducing downtime**.** With seamless connectivity and predictive insights**,** Intellipod optimizes performance and enhances process control across industries.

Figure 1: Intellipod

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Machine to Cloud Connecting EDGE Device- M2C-EDGE-LINK

Product Overview: The M2C-EDGE-LINK is a universal cloud-connected digital interpreter designed for seamless machine-to-cloud integration. It supports OPCUA, Modbus TCP, RS485, and RS232, enabling secure data transmission for real-time monitoring, process control, and predictive maintenance. The device facilitates remote task assignment, performance tracking, and OEE calculations, providing insights through a user-friendly dashboard for operators and supervisors. By capturing, processing, and analysing real-time machine data, it enhances industrial automation, process optimization, and remote machine management. Data is securely transmitted to cloud servers, ensuring centralized storage and remote access. With multi-protocol support and cloud-based analysis, industries can optimize operations, improve productivity, and reduce downtime. The M2C-EDGE-LINK empowers businesses with real-time insights and predictive maintenance capabilities, leading to better decision-making and more resilient manufacturing processes.

M2C Edge Link with machine

M2C edge link

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IIoT Enabled Unified Control Panel for Smart Foundry

Introduction

The Smart Foundry project aims to improve small-scale metal casting by integrating advanced automation and IIoT capabilities. The system consists of three key units: a 3D Printer, a Moulding Unit, and a Melting & Pouring Unit. By digitizing and automating the foundry process, the solution enhances quality, reduces costs, and improves operational efficiency.

Solution Overview

The IIoT-enabled Unified Control Panel (UCP) is designed to seamlessly integrate and manage the three subsystems of the Smart Foundry. This centralized control system ensures synchronized operations, real-time monitoring, and process optimization, enhancing productivity and precision in casting.

Key Features

- Unified Process Control – Centralized control panel for seamless coordination of 3D printing, moulding, and casting operations.
- Real-Time Monitoring – Tracks critical process parameters such as temperature, pressure, and material flow for quality assurance.
- IIoT Connectivity – Enables remote monitoring, data logging, and predictive maintenance through cloud integration.
- Automated Workflow – Reduces manual intervention with automated process execution and smart decision-making algorithms.

Figure 1: User Screens for IIoT Enabled Unified Control Panel for Smart Foundry

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Smart Integrated Foundry system

Introduction

The Integrated Smart Foundry is a fully automated system that streamlines the metal casting process by integrating 3D printing, automated mould preparation, and precision metal pouring into a single, IIoT-enabled system. The foundry is designed for minimal human intervention, ensuring high precision, efficiency, and consistency in casting operations.

Solution Overview

The system comprises four key modules:

- 3D FDM Printer – Prints high-accuracy polymer patterns for mould preparation.
- Automatic Moulding Unit – Mixes sand with resin, hardener, and catalyst and automatically creates moulds.
- Melting & Pouring Unit – Melts and pours up to 4kg of Aluminium with controlled preheating and auto cut-off features.
- IIoT-Enabled Unified Control Panel – Seamlessly connects and automates all foundry operations.

Key Features

- Smart 3D Printing – FDM-based printer with 200x200x200 mm build size, ±0.2mm accuracy, and cloud monitoring capabilities.
- Automated Sand Mixing & Moulding – Prepares customizable sand-resin moulds, supports 35kg sand storage, and automatically transfers moulds.
- Precision Melting & Pouring – Melts 4kg Aluminium in 30 mins, preheats alloys up to 5000°C, and includes auto metal pouring detection.
- IIoT-Enabled Control – Provides real-time monitoring, predictive maintenance, and data analytics for smart process optimization.

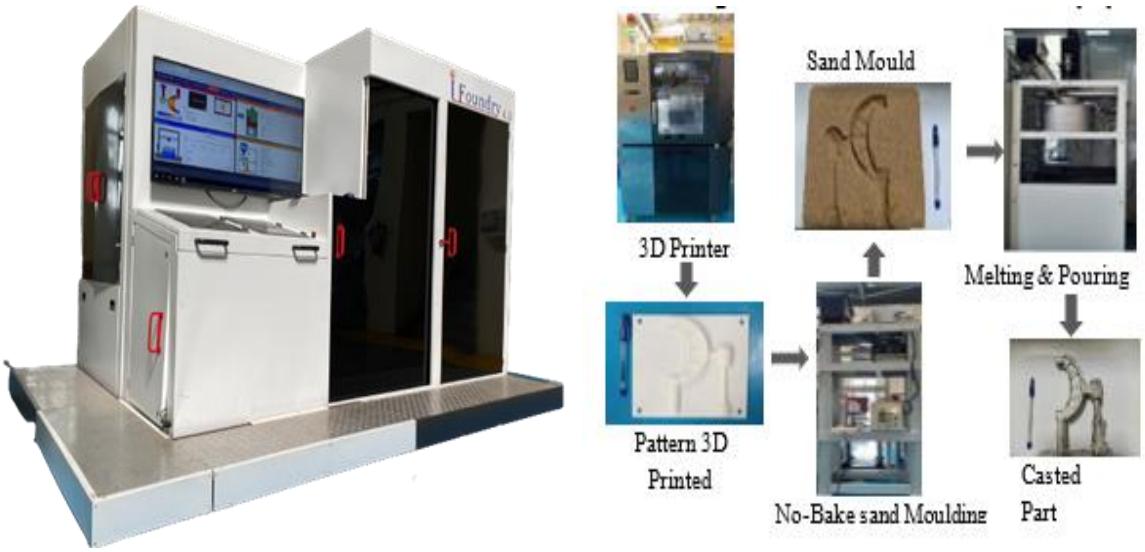

Figure 1: Smart Foundry & Process step for obtaining a casted part using smart foundry

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Smart Tool Holder.

Introduction

The Smart Tool Holder is an intelligent tool monitoring system designed to enhance machining performance by measuring real-time forces and moments acting on the cutting tool. Traditional machining setups lack direct force measurement, leading to unexpected tool failures, suboptimal cutting conditions, and increased downtime. The Smart Tool Holder addresses these challenges by integrating advanced sensors, wireless communication, and data analytics, enabling real-time monitoring of machining forces.

Solution Overview: The Smart Tool Holder measures key machining forces and moments, including:

- The tool holder equipped with force sensors strategically placed to measure forces and moments.
- Software & Analytics – A real-time dashboard that displays force, torque, and temperature data, enabling predictive maintenance and tool health assessment.
- Wireless Connectivity **–** Ensures seamless data transmission to cloud-based or on-premise monitoring systems.

Key Features

- Real-time Force Measurement – Captures axial force, torque, and bending moments in both X and Y direction.
- Data Visualization & Analytics Software – Provides insights for optimizing machining processes with both live and Analyser.

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AI enabled Automated Weld Defect Detection System

Introduction

The weld defect detection system is based on AI model that can detect and classify welding defects occurring in welding during real-time using IR images. The system uses highly optimized image classification model which was trained with a huge custom dataset to give accurate results. It enables the identification and classification of defects and delivers real-time solutions.

Solution Overview:

Key inspections include:

- Crack
- Porosity
- Spatter
- Weld overlap
- Burn through

Key Features:

- Defect identification- Accurately identifies weld imperfections and precisely identifies the weld defect location.
- Defect classification- Surface weld defect detection like Porosity, Discontinuity, Spatter, Burn-through and Weld overlap.
- Real time defect detection-Live defect detection during the welding process.

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