Pimpri Chinchwad Education Trust's
Pimpri Chinchwad College of Engineering

Major Project Synopsis

Department: Computer Engg. **Academic Year:** 2025 -2026 **Semester:** VII
Year: B. Tech. (Scheme A) **Div: A** **Group ID:GA8** **Date:**

Problem Statement:

AI-Powered CNC Quotation and Production Optimization Web Platform for Tech Support.

Project Domain: Artificial Intelligence and Manufacturing Automation

SIG: Machine Intelligence and Robotics

Sustainable Development Goal (SDG): Goal 9 – Industry, Innovation, and Infrastructure

Team Members:

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Sponsorship if any:
Company Name: TECH SUPPORT I & E – Powered Solution Empowered Trust
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Note: This is a non-paid consultancy-based project in collaboration with TECH SUPPORT I & E, offering real-world industrial exposure in CNC-based fabrication automation.

Name of External Guide:
Ms. Sanchi Gajghate
Management Representative, TECH SUPPORT I & E

Abstract:

In modern CNC fabrication and custom part manufacturing, the generation of precise cutting parameters and accurate quotations remains a manual, time-consuming process susceptible to human error. These inefficiencies contribute to delayed production, suboptimal material utilization, and inconsistent cost estimations. A unified AI-driven platform is proposed to automate CNC cutting operations and enable real-time, dynamic quotation generation. The system employs artificial intelligence, machine learning, and computer vision to interpret CAD files, determine optimal cutting paths, and calculate precise machining parameters. By automatically estimating material usage, machining time, and production cost, the platform delivers instant and accurate quotations while optimizing manufacturing workflows. This approach reduces manual intervention, minimizes errors, and enhances efficiency, scalability, and cost-effectiveness for industries requiring high precision and rapid turnaround.

Related Work:

While research and industrial tools have explored the use of AI in CNC machining and manufacturing automation, existing approaches exhibit notable limitations. Machine learning algorithms have been applied for toolpath optimization and cutting parameter prediction, and commercial CAM software has begun incorporating AI-based features. However, these solutions typically operate in isolation, lacking seamless integration with dynamic quotation systems. Computer vision techniques have been used for part recognition and estimation, yet their application remains fragmented and disconnected from end-to-end automation. This gap underscores the need for a unified platform that not only optimizes cutting operations but also delivers real-time, accurate quotations within a single, integrated workflow.

Innovative concept and relevance of the topic:

The project introduces an innovative AI-based platform that integrates CNC cutting optimization with real-time quotation automation. Unlike traditional systems where these operations are handled separately, this unified approach uses machine learning, computer vision, and optimization algorithms to interpret CAD files, generate efficient toolpaths, estimate cutting time, and instantly calculate quotations. This enhances production accuracy, reduces material waste, and minimizes human intervention. The topic is highly relevant in the current manufacturing era where automation, speed, and customization are essential to stay competitive.

Market potential and competitive advantage:

With the rapid adoption of Industry 4.0 and the growing demand for smart, on-demand manufacturing, there is significant market potential for intelligent CNC automation tools. Small to medium-scale fabrication units and custom manufacturing firms often struggle with manual quoting and inefficient cutting operations. This platform provides them with a cost-effective solution that enhances productivity, accuracy, and turnaround time. Its competitive advantage lies in its unified AI-driven approach, which not only optimizes cutting operations but also automates pricing—features not commonly bundled together in existing solutions. The system's scalability and adaptability to different materials and machine types make it a valuable asset across a wide range of manufacturing industries.

Project Objectives :

1. To study and analyze the influence of material type, thickness, and CNC machine type (laser/waterjet) on cutting parameters such as speed, pressure, and toolpath, and to develop an AI-based recommender system for optimal configuration.
2. To examine existing material nesting strategies for minimizing wastage and to implement an automated material optimization algorithm for efficient part arrangement.
3. To evaluate and implement methods for estimating cutting time, calculating costs, and structuring client-ready documentation.
4. To develop an integrated quotation generation module for producing accurate PDFs for TECH SUPPORT I & E.

Technical Details :

- Backend Language: Python
- AI/ML Libraries: scikit-learn, pandas
- Computer Vision & Nesting: OpenCV, PyNest
- Web Framework: Flask or Django (for backend API)
- Frontend: React.js (for user interface)
- Database: SQLite or MySQL
- CAD File Integration: AutoCAD file parsing using DXF libraries (e.g., ezdxf)
- PDF Generation: Python libraries like ReportLab or FPDF

Technical Key Words :

- Artificial Intelligence
- Computer Vision
- Machine Learning
- Manufacturing Automation
- Optimization Algorithms
- Human-Centered Computing – Computer-aided design (CAD)
- Applied Computing – Operations research
- Web Applications

Relevant mathematical models associated with the Project:

- Regression Models for cutting time and cost estimation
- Classification Algorithms for recommending cutting parameters based on material properties
- Geometric Nesting Algorithms for optimal layout and material utilization
- Travelling Salesman Problem (TSP) Heuristics for toolpath optimization
- Linear and Integer Programming for material usage and pricing optimization
- Time Complexity Analysis for evaluating algorithm performance and scalability

Plan of the conference/journal (Such as IEEE/Springer/Scopus Journal) where paper will publish or Patent/ Copyright of project.

References: List of Conference/Journal Papers supporting project idea

[1] X. Liu and Y. Zhang, "AI-Powered CNC Toolpath Optimization," Journal of Intelligent Manufacturing, 2023.
[2] R. Kumar, "Automated Quotation System for Smart Factories," International Journal of AI and Automation, 2022.
[3] A. Singh, "CNC Efficiency through Computer Vision," Machine Vision Applications, 2024.
[4] H. Gupta et al., "CAD Feature Recognition Using Machine Learning," Springer Manufacturing Series, 2023.
[5] Q. Li, "Toolpath Generation in Smart CAM Systems," Elsevier Journal of Manufacturing Technology, 2024.
[6] Bosch Research, "AI in Predictive Manufacturing," [White Paper], 2022.
[7] MIT Research Group, "CNC AI Interfaces for Custom Manufacturing," 2023.
[8] IEEE Standards Association, "Edge-AI for Manufacturing Automation," 2023.
[9] Accenture, "Digital Twins and Smart Manufacturing," [Industry White Paper], 2024.
[10] OpenAI, "Applications of Generative AI in Industrial Automation," [White Paper], 2023.
[11] TechCrunch, "How Startups Are Disrupting Manufacturing with AI Tools," 2022.
[12] Autodesk, "Integration of AI in CAD/CAM Systems," [Technical Blog], 2023.

Targets from project:

-Paid Consultancy project
-Sponsored Project
-Scopus/SCI Paper Publication
-Patent
-Project competition and awards

Name and signature of Project Guide