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# APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN COMPUTER-AIDED MANUFACTURING

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## ABSTRACT

Artificial intelligence involves the development of algorithms and models that can analyze data, recognize patterns, make decisions, and solve problems in a way that mimics human thinking. AI plays a significant role in computer aided manufacturing to detect the real time data, defects, making manufacturing process easy and fast with good accuracy and precision. AI helps to optimize the design of the products and also makes the products cost-effective, efficient. By data collection and analysis AI model is designed, tested in the industry then integrated with the CAM.

**Keywords:** Artificial Intelligence (AI), Computer Aided Manufacturing (CAM), Applications, Equations.

## I. INTRODUCTION

Artificial intelligence (AI) has a wide range of applications in computer-aided manufacturing (CAM), which is the use of computer software to assist with manufacturing processes. AI techniques, such as ML, computer vision, and language processing, can be used to improve various aspects of CAM, including design, planning, monitoring, and control. For example, AI can be used to optimize the design of parts and products, to generate manufacturing plans that are efficient and cost-effective, to monitor production processes in real-time, and to identify and diagnose potential issues or defects. AI can also help to improve the quality of products and reduce waste and errors.

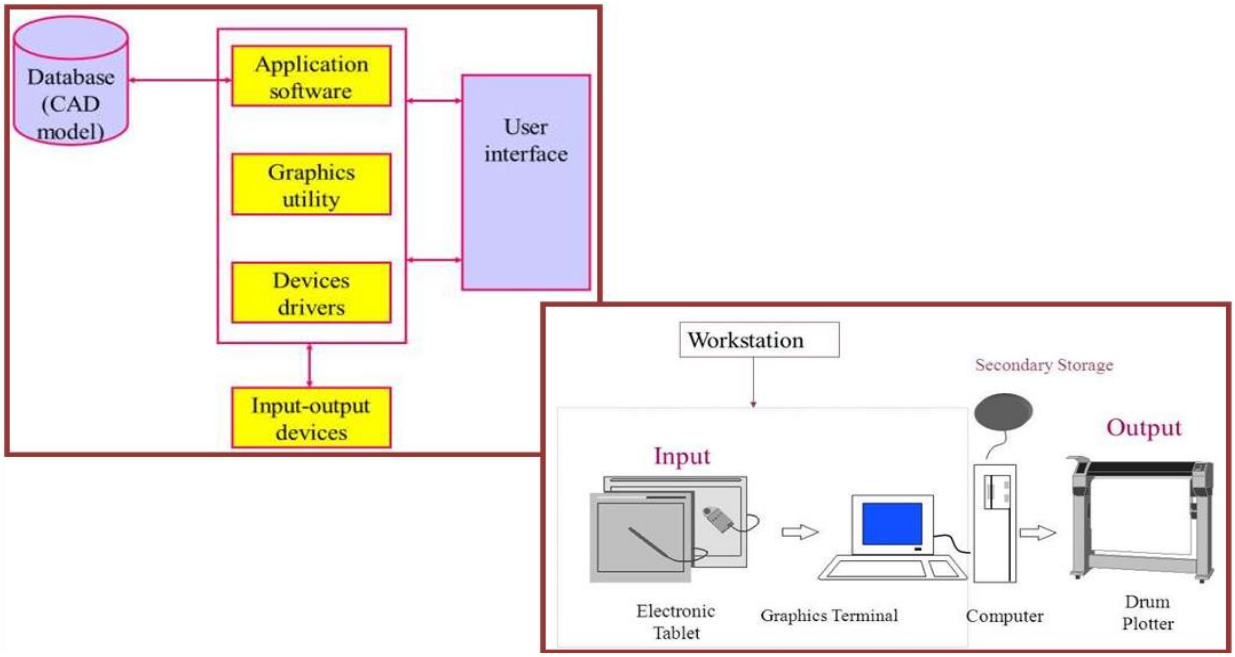


**Fig 1:** CAM Layout

Overall, the application of AI in CAM has the potential to improve manufacturing efficiency, reduce costs, and enhance product quality, making it an important area of research and development for many companies and organizations in the manufacturing industry.

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## II. LITERATURE REVIEW

| S No. | Title | Author(s), Year & Journal | Findings |
|---|---|---|---|
| 1. | "Assessment of Chair-side Computer-Aided Design and Computer-Aided Manufacturing Restorations: A Review of the Literature" | "Kusai Baroudi and Shukran Nasser Ibraheem, 2015, Journal of International Oral Health" | In all dental specialties, chair-side CAD/CAM technology has the ability to reduce the time and effort required by dentists, staff, and patients to restore oral function and appearance while delivering high-quality results. |
| 2. | "Trends in Computer-Aided Manufacturing in Prosthodontics: A Review of the Available Streams" | "Jaafar Abduo, Karl Lyons, Mohammed Bennamoun, 2014, International Journal of Dentistry" | CAM used in dentistry is extremely likely to happen in the near future as it continues to see considerable and frequent advancements. Subtractive milling has been proven to be a good technique for creating intraoral prosthesis, and it is now the most extensively used computer-aided manufacturing process in dentistry. |
| 3. | "A Theory of Innovation Processes for Computer-Aided Manufacturing Technology" | "DONALD GERWIN, 1988 IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT" | The interconnected claims describe the adoption, planning, implementation processes for computerised technology. This is done in terms of the issues brought on by uncertainty and the coping mechanisms employed to deal with them. As a result, the idea clarifies why it is so challenging to use new technologies in businesses. |
| 4. | "A review of computer-aided design/computer-aided manufacture techniques for removable denture fabrication" | "Mehmet Selim Bilgin, Ebru Nur Baytaroğlu, Ali Erdem, Erhan Dilber, 2019, European Journal of Dentistry" | The first contemporary detachable dentures were made using PMMA, but until the advent of CAD/CAM technology in the 1990s, nothing had changed in terms of fabrication methods. As a result, patients and dentists spend less time in the chair and have better or more |

| | | | |
|---|---|---|---|
| | | | satisfying functional and cosmetic results. Recent advancements in dental technology enable the manufacturing of removable dentures utilising CAD/CAM technologies from beginning to end. |
| 5. | "An experimental design approach using TOPSIS method for the selection of computer-integrated manufacturing technologies" | "Yusuf Tansel iç, 2012, Robotics and Computer-Integrated Manufacturing" | The choice of Computer-Integrated Manufacturing (CIM) technology becomes more challenging when decision-makers in manufacturing organisations must assess a wide range of options based on a set of criteria. Even though there are a number of Multi-Attribute Decision-Making (MADM) techniques that can be used for selection applications, the objective of this study is to determine whether an integrated TOPSIS and DoE approach can be used to solve various CIM selection problems in real-time industrial applications. |

## III. METHODOLOGY

1. Data collection: The first step in implementing AI in CAM is to collect data on the manufacturing process. This includes data on the design of the product, the manufacturing process itself, and the materials used. This data is typically collected from sensors, equipment, and other sources.

2. Data preparation: Once the data is collected, it needs to be cleaned and prepared for use in AI models. This involves removing any irrelevant or inaccurate data, and formatting the data in a way that can be used by machine learning algorithms.

3. AI model selection: Next, the appropriate AI model is selected based on the specific application. For example, computer vision algorithms may be used to detect defects in a product, while machine learning algorithms may be used to optimize the manufacturing process.

4. AI model training: The selected AI model is then trained using the prepared data. This involves feeding the model with a large amount of data to teach it to recognize patterns and make predictions.

5. Model testing and validation: After training, the model is tested and validated to ensure that it is accurate and reliable. This involves using a separate set of data to evaluate the model's performance.

6. Integration into CAM: Once the AI model has been trained and validated, it can be integrated into the CAM system. This involves developing an interface between the AI model and the manufacturing equipment and processes.

7. Ongoing maintenance: Finally, the AI model needs to be regularly maintained and updated to ensure that it continues to perform well over time. This includes monitoring its performance and making adjustments as necessary.

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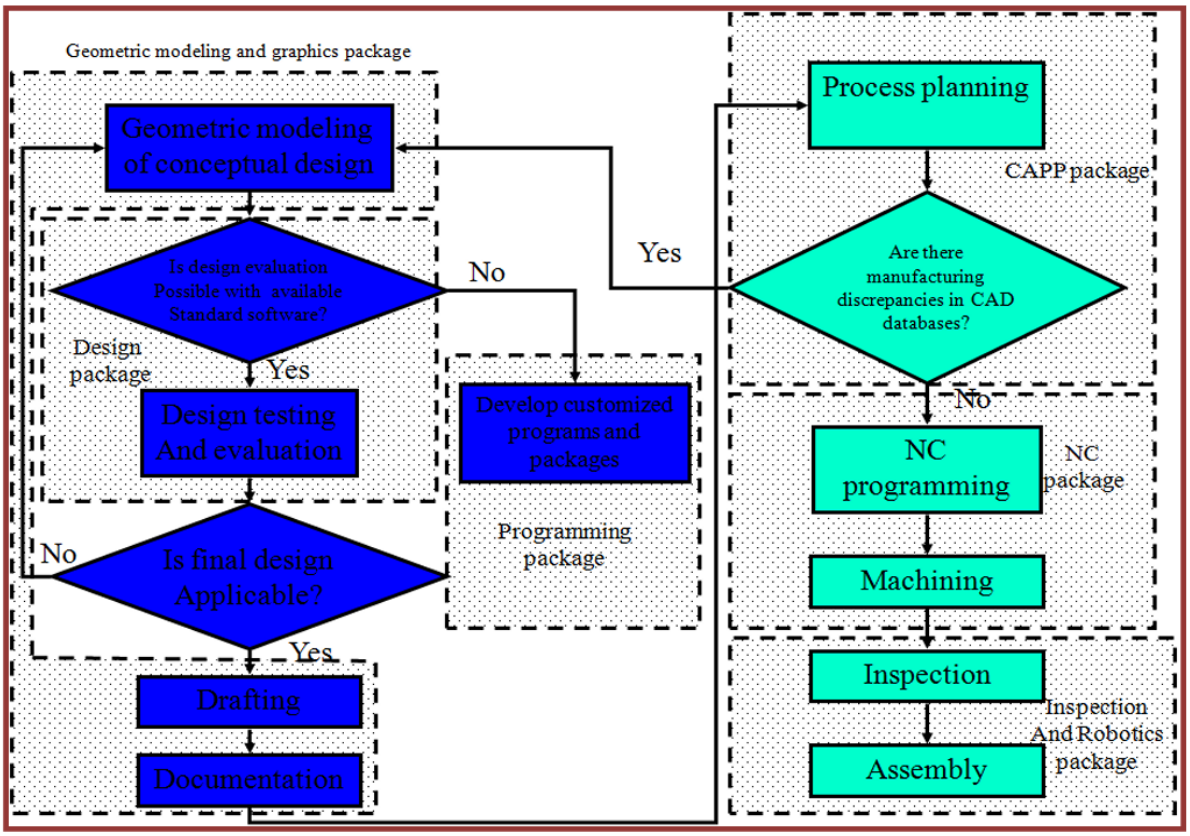


**Fig 2:** Flowchart

Overall, the methodology of AI in CAM involves a data-driven approach to improving manufacturing processes, with a focus on selecting and training the appropriate AI model and integrating it into the CAM system.

## IV. MATHEMATICAL EQUATIONS

➢ Trigonometry: Trigonometry is used to calculate angles and distances in many manufacturing processes.

$$\textit{Sine rule: } \sin(x)/X = \sin(y)/Y = \sin(z)/Z$$
$$\textit{Cosine rule: } X^2 = Y^2 + Z^2 - 2YC\cos(x)$$
$$\textit{Tangent rule: } \tan(a) = \text{opposite}/\text{adjacent}$$

These equations are used to calculate the angles and distances required for cutting tools to produce a desired shape.

➢ Geometry: Geometry is used to calculate the dimensions and positions of components in many manufacturing processes.

$$\textbf{Distance formula: } d = \text{sqrt}((a2 - a1)^2 + (b2 - b1)^2)$$
$$\textbf{Midpoint formula: } ((a1 + a2)/2, (b1 + b2)/2)$$

These equations are used to model and design parts in a manufacturing process.

➢ Calculus: Calculus is used to optimize manufacturing processes by determining maximum or minimum values.

$$\textbf{Derivative of a function: } f'(x) = \lim_{a \to 0} (f(x+a) - f(x))/a$$
$$\textbf{Optimization equation: } f'(x) = 0$$

These equations are used to optimize the speed and feed rates of a CNC machine to minimize machining time while maintaining part quality.

## V. APPLICATIONS IN INDUSTRIES

The use of AI in computer-aided manufacturing (CAM) is becoming increasingly common, but it is still in its early stages of adoption. While many companies are beginning to explore the use of AI in CAM, adoption rates are still relatively low. According to a survey by McKinsey, only 16% of manufacturers are currently using AI in

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their operations. The most common applications of AI in CAM are quality control, predictive maintenance, production planning, and material optimization. However, there is also growing interest in using AI for robotics and automation, supply chain management, and energy management.

| INDUSTRY | USES |
|---|---|
| Quality Control | AI used to identify defects and anomalies in products by analyzing images of manufactured parts. According to a report by Markets and Markets, the global market for AI in manufacturing is expected to grow from $1.1 billion in 2018 to $17.2 billion by 2025, driven in part by the increasing use of AI in quality control. For example, General Electric uses AI-powered vision systems to inspect jet engine parts for defects. |
| Predictive Maintenance | AI can be used to monitor machines and predict when they will require maintenance, helping to prevent breakdowns and reduce downtime. According to a survey by Deloitte, 74% of manufacturers say that predictive maintenance is one of the top benefits of using AI in their operations. For example, Siemens uses AI to monitor the performance of its wind turbines and predict when maintenance is needed. |
| Material Optimization | AI used to optimize the use of materials in the manufacturing process, reducing waste and improving efficiency. According to a report by PwC, 65% of manufacturers believe that AI can help to reduce waste in their operations. For example, Airbus uses AI to optimize the cutting of carbon fiber materials for its aircraft, resulting in a 30% reduction in waste. |
| Robotics and Automation | AI is used to control robots and automate tasks in the manufacturing process, such as assembly and packaging. According to a report by CB Insights, investment in AI-powered robotics companies has grown by 56% over the past five years. For example, Foxconn, the world's largest contract electronics manufacturer, is using AI-powered robots to assemble components for smartphones. |
| Energy Management | AI can be used to optimize energy consumption in manufacturing plants, reducing costs and improving sustainability. According to a report by Deloitte, 70% of manufacturers believe that AI can help to improve energy efficiency in their operations. For example, Schneider Electric uses AI to optimize the energy consumption of its manufacturing facilities, resulting in a 10% reduction in energy costs. |

## VI. FUTURE DEVELOPMENTS

Artificial intelligence (AI) has already begun to transform the field of computer-aided manufacturing (CAM), and it is expected to continue to do so in the future. AI algorithms can analyze manufacturing data in real-time and identify patterns that indicate quality issues, enabling early detection and correction of defects. This can help to reduce waste and improve overall product quality. AI can analyze large amounts of data and identify the most efficient ways to manufacture products. This can include optimizing machine settings, scheduling production runs, and reducing downtime. Help manufacturers optimize their processes to reduce waste, energy consumption, and greenhouse gas emissions, leading to a more sustainable manufacturing industry.

## VII. CONCLUSION

Artificial intelligence is playing a significant role in the computer aided manufacturing (CAM) industry. Artificial intelligence is implemented with data collection and preparation after that preparing the AI model, testing and then integration with the CAM. The AI algorithm is used in many aspects of the CAM industry like quality control, energy management, robotics and automation, maintenance, material optimization. Also in future AI can be used to analyze the real time data to detect quality issues, defects and perfection which shows that AI is having a great scope in future in computer aided manufacturing industry.

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