International Journal of Research Publication and Reviews, Vol (6), Issue (4), April (2025), Page – 14014-14015

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Application of Artificial Intelligence for Estimation of Appropriate Machining Parameters

Om A. Kokate[1], Jay S. Thakare[2] ,Kunal G. Pawar[3],Rahul D. Awasthi [4],Amol K. Kulat[5]

Department of Mechanical Engineering,
Shri Sant Gajanan Maharaj College of Engineering, Shegaon, Buldhana

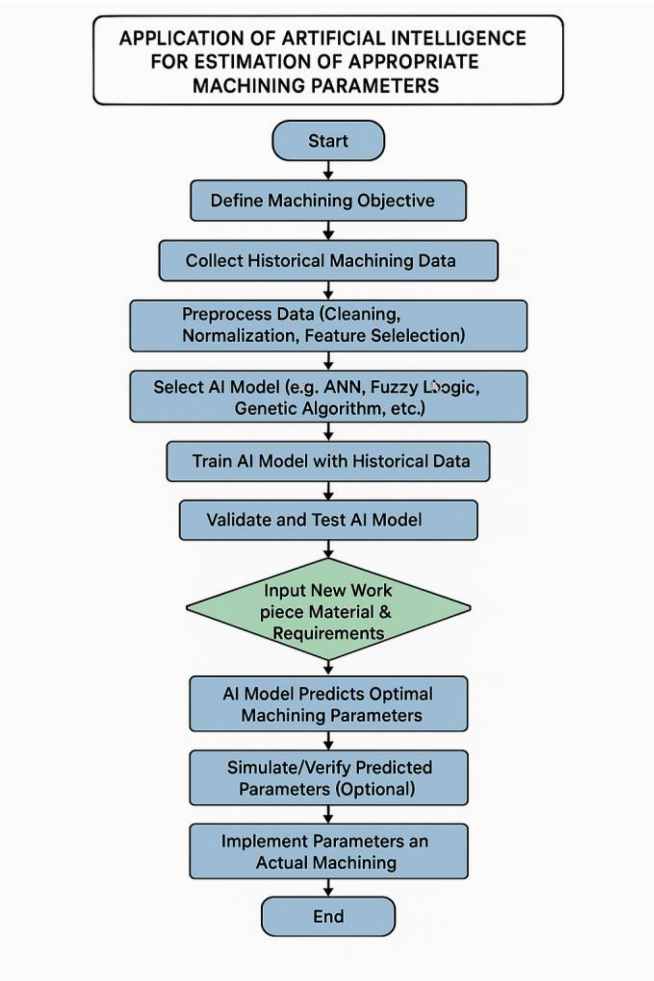
ABSTRACT—

Optimizing machining parameters is vital for enhancing productivity, achieving superior surface finishes, and extending tool life in manufacturing operations. Traditional approaches, which depend heavily on empirical modeling and trial-and-error methods, often struggle with capturing complex nonlinear interactions among machining variables. This review investigates the deployment of artificial intelligence (AI) techniques — notably artificial neural networks (ANN), gene expression programming (GEP), adaptive neuro-fuzzy inference systems (ANFIS), and genetic algorithms (GA) — to predict and optimize machining parameters like surface roughness, material removal rate, and cutting forces. It consolidates insights from recent research, highlighting methodologies, prevailing challenges, and future directions in AI-driven machining optimization.

Index Terms—Artificial Intelligence, Genetic Algorithm, Machining Parameters, Neural Networks, Optimization, Surface Roughness

I. INTRODUCTION

Machining processes such as turning, milling, and drilling are fundamental pillars of manufacturing. Selecting appropriate machining parameters is critical to achieving desired surface quality, minimizing power consumption, and enhancing tool life. In recent years, AI has emerged as a transformative tool in parameter estimation, offering a more sophisticated alternative to traditional trial-and-error strategies.



II. METHODOLOGY FOR LITERATURE SEARCH

Relevant literature was gathered from peer-reviewed journals, including AIP Advances, Materials Today Proceedings, International Journal of Advanced Manufacturing Technology, and others. Selection criteria included publication recency, relevance to AI-based machining parameter optimization, and quality of research. Keywords such as "machining parameter optimization," "artificial intelligence," "neural networks in machining," and "genetic algorithm machining" guided the search for pertinent studies.

III. REVIEW OF LITERATURE

Bhowmik et al. [1] evaluated GEP, ANN, and ANFIS for predicting machining outcomes of Inconel 690, finding GEP to deliver the highest accuracy with an R^2 value reaching 0.993. Kosarac et al. [2] demonstrated the effectiveness of ANNs in modeling surface roughness for aluminum alloys, even when working with limited data sets. Muthuram et al. [3] combined ANN with GA to optimize turning parameters for titanium alloys, successfully minimizing surface roughness while maintaining a balanced material removal rate. Palanisamy et al. [4] showed that GA could efficiently optimize multiple machining parameters, simultaneously reducing machining time and improving surface quality. El Hossainy et al. [5] introduced a hybrid soft computing method integrating fuzzy logic, neural networks, and genetic algorithms to derive optimal machining settings based on user-defined objectives.

IV. CHALLENGES AND LIMITATIONS

Despite its advantages, the application of AI in machining faces several challenges, including the requirement for large datasets, risks of model overfitting, and limited interpretability of model decisions. Additionally, industrial-scale real-time deployment remains constrained by computational demands and integration complexities.

V. FUTURE DIRECTIONS

Future research efforts should aim at developing hybrid AI models, implementing real-time adaptive control mechanisms, and enlarging training datasets through simulations and transfer learning techniques. The integration of AI approaches with Industry 4.0 technologies and IoT-based monitoring systems offers promising avenues for providing dynamic feedback and enhancing machining parameter optimization.

VI. CONCLUSION

Artificial intelligence offers robust capabilities for predicting and optimizing machining parameters. From ANNs and GEP to hybrid frameworks incorporating fuzzy logic and genetic algorithms, these tools adeptly model complex system behaviors and improve process efficiency. Their increasing adoption in manufacturing processes promises significant advancements in productivity, quality, and sustainability.

REFERENCES

[1] A. Bhowmik, et al., "Performance evaluation of machine learning algorithms in predicting machining responses of superalloys," AIP Advances, vol. 14, 2024, Art no. 105027.
[2] A. Kosarac, et al., "Neural-Network-Based Approaches for Optimization of Machining Parameters Using Small Dataset," Materials, vol. 15, 2022, Art no. 700.
[3] N. Muthuram and F. C. Frank, "Optimization of machining parameters using artificial intelligence techniques," Materials Today: Proceedings, 2021.
[4] P. Palanisamy, et al., "Optimization of machining parameters using genetic algorithm and experimental validation for end-milling operations," International Journal of Advanced Manufacturing Technology, 2007.
[5] T. M. El Hossainy, et al., "Machining process parameters optimization using soft computing technique," Journal of Engineering and Applied Science, vol. 70, no. 7, 2023.