APEM journal

Advances in Production Engineering & Management
Volume 20 | Number 2 | June 2025 | pp 224–238
https://doi.org/10.14743/apem2025.2.537

ISSN 1854-6250
Journal home: apem-journal.org
Original scientific paper

Large language models for G-code generation in CNC machining: A comparison of ChatGPT-3.5 and ChatGPT-4o

Šket, K.[a,*], **Potočnik, D.**[a], **Brezocnik, M.**[a], **Ficko, M.**[a], **Klančnik, S.**[a]

[a]University of Maribor, Faculty of Mechanical Engineering, Maribor, Slovenia

ABSTRACT

This research explores the viability of producing ISO G-code for 3-axis machining with OpenAI's Chat Generative Pre-Trained Transformer models, particularly ChatGPT-3.5 and the newer GPT-4o. G-code (RS-274-D, ISO 6983) converts human directives into commands that machines can understand, controlling toolpaths, spindle velocities, and feed rates to produce particular aspects of an object. Previously, G-code was generated either by hand or through the use of computer-aided manufacturing (CAM) software along with machine-specific post-processors, both of which may require considerable time and expense. This research aimed to assess the practicality and effectiveness of specific large language models (LLMs) in generating G-code. The assessment took place in three distinct phases on a sample component that required 3-axis machining. These phases included: (1) the self-generated production of G-code for the sample component, (2) the examination of the independently generated G-code in the CAM application, and (3) the recognition and justification of mistakes in the G-code. The outcomes indicated varying abilities with promising findings. This method could accelerate and possibly enhance manufacturing workflows by decreasing reliance on expensive CAM software and specialized knowledge.

ARTICLE INFO

Keywords:
Generative artificial intelligence;
Intelligent manufacturing;
Large language models (LLM);
ChatGPT;
CNC machining;
G-code programming

**Corresponding author:*
kristijan.sket@um.si
(Šket, K.)

Article history:
Received 9 May 2025
Revised 13 June 2025
Accepted 19 June 2025

References

[1] Li, B.-H., Hou, B.-C., Yu, W.-T., Lu, X.-B., Yang, C.-W. (2017). Applications of artificial intelligence in intelligent manufacturing: A review, *Frontiers of Information Technology & Electronic Engineering*, Vol. 18, 86-96, doi: 10.1631/FITEE.1601885.

[2] Yang, T., Yi, X., Lu, S., Johansson, K.H., Chai, T. (2021). Intelligent manufacturing for the process industry driven by industrial artificial intelligence, *Engineering*, Vol. 7, No. 9, 1224-1230, doi: 10.1016/j.eng.2021.04.023.

[3] Tao, F., Qi, Q., Liu, A., Kusiak, A. (2018). Data-driven smart manufacturing, *Journal of Manufacturing Systems,* Vol. 48, Part C, 157-169, doi: 10.1016/j.jmsy.2018.01.006.

[4] Davis, J., Edgar, T., Graybill, R., Korambath, P., Schott, B., Swink, D., Wang, J., Wetzel, J. (2015). Smart manufacturing, *Annual Review of Chemical and Biomolecular Engineering,* Vol. 6, 141-160, doi: 10.1146/annurev-chembioeng-061114-123255.

[5] Wan, J., Li, X., Dai, H.-N., Kusiak, A., Martinez-Garcia, M., Li, D. (2021). Artificial-intelligence-driven customized manufacturing factory: Key technologies, applications, and challenges, *Proceedings of the IEEE*, Vol. 109, No. 4, 377-398, doi: 10.1109/JPROC.2020.3034808.

[6] Lee, J., Davari, H., Singh, J., Pandhare, V. (2018). Industrial artificial intelligence for industry 4.0-based manufacturing systems, *Manufacturing Letters,* Vol. 18, 20-23, doi: 10.1016/j.mfglet.2018.09.002.

[7] Yao, X., Zhou, J., Zhang, J., Boer, C.R. (2017). From intelligent manufacturing to smart manufacturing for industry 4.0 driven by next generation artificial intelligence and further on, In: *Proceedings of 2017 5th International Conference on Enterprise Systems (ES),* Beijing, China, 311-318, doi: 10.1109/ES.2017.58.

[8] Heiden, B., Alieksieiev, V., Volk, M., Tonino-Heiden, B. (2021). Framing artificial intelligence (AI) additive manufacturing (AM), *Procedia Computer Science,* Vol. 186, 387-394, doi: 10.1016/j.procs.2021.04.161.
[9] Rane, N., Choudhary, S., Rane, J. (2024). Intelligent manufacturing through generative artificial intelligence, such as ChatGPT or Bard, *SSRN Electronic Journal*, doi: 10.2139/ssrn.4681747.
[10] Wang, X., Anwer, N., Dai, Y., Liu, A. (2023). ChatGPT for design, manufacturing, and education, *Procedia CIRP*, Vol. 119, 7-14, doi: 10.1016/j.procir.2023.04.001.
[11] Javaid, M., Haleem, A., Singh, R.P. (2023). A study on ChatGPT for industry 4.0: Background, potentials, challenges, and eventualities, *Journal of Economy and Technology*, Vol. 1, 127-143, doi: 10.1016/j.ject.2023.08.001.
[12] Badini, S., Regondi, S., Frontoni, E., Pugliese, R. (2023). Assessing the capabilities of ChatGPT to improve additive manufacturing troubleshooting, *Advanced Industrial and Engineering Polymer Research*, Vol. 6, No. 3, 278-287, doi: 10.1016/j.aiepr.2023.03.003.
[13] Sriwastwa, A., Ravi, P., Emmert, A., Chokshi, S., Kondor, S., Dhal, K., Patel, P., Chepelev, L.L., Rybicki, F.J., Gupta, R. (2023). Generative AI for medical 3D printing: A comparison of ChatGPT outputs to reference standard education, *3D Printing in Medicine,* Vol. 9, Article No. 21, doi: 10.1186/s41205-023-00186-8.
[14] Jignasu, A., Marshall, K., Ganapathysubramanian, B., Balu, A., Hegde, C., Krishnamurthy, A. (2023). Towards foundational AI models for additive manufacturing: Language models for G-code debugging, manipulation, and comprehension, *ArXiv,* doi: 10.48550/arXiv.2309.02465.
[15] Thirunavukarasu, A.J., Ting, D.S.J., Elangovan, K., Gutierrez, L., Tan, T.F., Ting, D.S.W. (2023). Large language models in medicine, *Nature Medicine,* Vol. 29, 1930-1940, doi: 10.1038/s41591-023-02448-8.
[16] Dai, W., Lin, J., Jin, H., Li, T., Tsai, Y.-S., Gašević, D., Chen, G. (2023). Can large language models provide feedback to students? A case study on ChatGPT, In: *Proceedings of 2023 IEEE International Conference on Advanced Learning Technologies (ICALT),* Orem, USA, 323-325, doi: 10.1109/ICALT58122.2023.00100.
[17] Chang, Y., Wang, X., Wang, J., Wu, Y., Yang, L., Zhu, K., Chen, H., Yi, X., Wang, C., Wang, Y., Ye, W., Zhang, Y., Chang, Y., Yu, P.S., Yang, Q., Xie, X. (2024). A survey on evaluation of large language models, *ACM Transactions on Intelligent Systems and Technology,* Vol. 15, No. 3, 1-45, doi: 10.1145/3641289.
[18] Devlin, J., Chang, M.-W., Lee, K., Toutanova, K. (2019). BERT: Pre-training of deep bidirectional transformers for language understanding, In: *Proceedings of the 2019 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies,* Minneapolis, USA, 4171-4186, doi: 10.18653/v1/N19-1423.
[19] Bouschery, S.G., Blazevic, V., Piller, F.T. (2023). Augmenting human innovation teams with artificial intelligence: exploring transformer-based language models, *Journal of Product Innovation Management*, Vol. 40, No. 2, 139-153, doi: 10.1111/jpim.12656.
[20] Pearce, K., Zhan, T., Komanduri, A., Zhan, J. (2021). A comparative study of transformer-based language models on extractive question answering, *ArXiv,* doi: 10.48550/arXiv.2110.03142.
[21] Kalla, D., Smith, N. (2023). Study and analysis of Chat GPT and its impact on different fields of study, *International Journal of Innovative Science and Research Technology*, Vol. 8, No. 3, 827-833, doi: 10.5281/zenodo.7767675.
[22] Chitsaart, C., Rianmora, S., Rattana-Areeyagon, M., Namjaiprasert, W. (2014). Automatic generating CNC-code for milling machine, *International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering*, Vol. 7, No. 12, 2607-2613.
[23] Zhang, Y., Zeng, Q., Mu, G., Yang, Y., Yan, Y., Song, W. , Gong, Y. (2018). A design for a novel open, intelligent and integrated CNC system based on ISO 10303-238 and PMAC, *Tehnički Vjesnik – Technical Gazette*, Vol. 25, No. 2, 470-478, doi: 10.17559/TV-20170419111243.
[24] Gu, Y., Wang, Y., Lin, J., Yuan, X. (2017). Fault location in CNC system software based on the architecture expansion, *Tehnički Vjesnik – Technical Gazette*, Vol. 24, No. 2, 619-625, doi: 10.17559/TV-20160704190047.