Advances in Production Engineering & Management
Volume 21 | Number 2 | June 2026 | pp 221–238
https://doi.org/10.14743/apem2026.2.570
ISSN 1854-6250
Journal home: apem-journal.org
Original scientific paper

A data-driven framework for intelligent product development of wearable health monitoring devices using deep learning

Wang, K.[a], Xiong, Z.[a], Li, K.X.[a], Liu, X.[a], Ji, G.J.[a], Liu, Q.Y.[a], Han, Y.[b], Li, B.Z.[c,*]

[a]Institute of Fine Arts and Design, Quanzhou Normal University, Quanzhou, P.R. China
[b]Faculty of Innovation and Design, City University of Macau, Macau, P.R. China
[c]School of the Arts, Huzhou University, Huzhou, P.R. China

ABSTRACT

The rapid growth of artificial intelligence (AI) has shifted the development of wearable health monitoring devices toward intelligent design. However, conventional approaches still rely heavily on experience, involve inefficient user requirement acquisition, and lack systematic support for innovation. To address these limitations, this study proposes a data-driven framework for intelligent product development that integrates deep learning, Kansei Engineering, and TRIZ theory. The framework establishes an AI-assisted workflow comprising online data acquisition, requirement identification, knowledge mapping, concept generation, and engineering optimization. First, web crawlers collect user reviews and product images. A convolutional neural network (CNN) identifies form features, while a generative adversarial network (GAN) generates diverse design concepts. Kansei Engineering then maps user requirements to design elements, and TRIZ theory resolves engineering contradictions to support systematic optimization. A case study of smart health watches, using a dataset of nearly 30,000 images and more than 12,000 reviews, demonstrates that the framework can effectively automate requirement extraction, concept generation, and design optimization. Compared with traditional experience-driven methods, the proposed framework significantly improves decision-making efficiency and supports product innovation. This study extends the application of deep learning to engineering design support and provides a transferable methodology for data-driven intelligent product development.

ARTICLE INFO

Keywords:
Intelligent product development;
Data-driven design;
Engineering design support;
Artificial intelligence;
Generative adversarial networks;
Deep learning;
Wearable health monitoring devices;
Sensory engineering;
AI-assisted product development

**Corresponding author:*
02305@zjhu.edu.cn
(Li, B.Z.)

Article history:
Received 30 October 2025
Revised 30 June 2026
Accepted 2 July 2026

References

[1] Janani, S.R., Subramanian, R., Karthik, S., Vimalarani, C. (2023). Healthcare monitoring using machine learning based data analytics, *International Journal of Computers Communications & Control*, Vol. 18, No. 1, Article No. 4973, doi: 10.15837/ijccc.2023.1.4973.
[2] Zhang, W., Thurow, K., Stoll, R. (2016). A context-aware mHealth system for online physiological monitoring in remote healthcare, *International Journal of Computers Communications & Control*, Vol. 11, No. 1, 142-156, doi: 10.15837/ijccc.2016.1.1333.
[3] Zaied, A.N.H., Elmogy, M., Abd Elkader, S. (2015). Electronic health records: Applications, techniques and challenges, *International Journal of Computer Applications*, Vol. 119, No. 14, 38-49, doi: 10.5120/21139-4153.
[4] Wang, X., Hu, B. (2024). Machine learning algorithms for improved product design user experience, *IEEE Access*, Vol. 12, 112810-112821, doi: 10.1109/ACCESS.2024.3442085.

[5] Kalaiarasu, M., Ranjeeth Kumar, C. (2022). Sentiment analysis using improved novel convolutional neural network (SNCNN), *International Journal of Computers Communications & Control*, Vol. 17, No. 2, Article No. 4351, doi: 10.15837/ijccc.2022.2.4351.

[6] Wan, X., Tian, L. (2024). User stress detection using social media text: A novel machine learning approach, *International Journal of Computers Communications & Control*, Vol. 19, No. 5, Article No. 6772, doi: 10.15837/ijccc.2024.5.6772.

[7] Li, X., He, Y., Peng, Q., Liu, W. (2022). A computer-aided approach for acquisition and importance ranking of customer requirements from the online comment mining, *Computer-Aided Design and Applications*, Vol. 19, No. 1, 132-151, doi: 10.14733/cadaps.2022.132-151.

[8] Zhang, Q., Geng, G., Tu, Q. (2023). Association mining-based method for enterprise's technological innovation intelligent decision making under big data, *International Journal of Computers Communications & Control*, Vol. 18, No. 2, Article No. 5241, doi: 10.15837/ijccc.2023.2.5241.

[9] Mustafa, M.A.S. (2025). Predictive reliability-driven optimization of spare parts management in aircraft fleets using AI, IoT, and digital twin technologies, *Journal of Engineering Management and Systems Engineering*, Vol. 4, No. 3, 218-236, doi: 10.56578/jemse040305.

[10] Chen, D., Cheng, P. (2022). Development of design system for product pattern design based on Kansei engineering and BP neural network, *International Journal of Clothing Science and Technology*, Vol. 34, No. 3, 335-346, doi: 10.1108/IJCST-04-2021-0044.

[11] Chanchí-Golondrino, G.E., Ospina-Alarcón, M.A., Sierra-Martínez, L.M. (2023). Determination of the satisfaction attribute in usability tests using sentiment analysis and fuzzy logic, *International Journal of Computers Communications & Control*, Vol. 18, No. 3, Article No. 4901, doi: 10.15837/ijccc.2023.3.4901.

[12] Iqbal, J.L.M., Kumar, M.S., Mishra, G., Asha, G.R., Saritha, A.N., Karthik, A., BonthuKotaiah, N. (2023). Facial emotion recognition using geometrical features based deep learning techniques, *International Journal of Computers Communications & Control*, Vol. 18, No. 4, Article No. 4644, doi: 10.15837/ijccc.2023.4.4644.

[13] Uma Maheswari, K., Rajesh, S. (2022). Fused LISS IV image classification using deep convolution neural networks, *International Journal of Computers Communications & Control*, Vol. 17, No. 5, Article No. 4521, doi: 10.15837/ijccc.2022.5.4521.

[14] Chai, C., Liao, J., Zou, N., Sun, L. (2018). A one-to-many conditional generative adversarial network framework for multiple image-to-image translations, *Multimedia Tools and Applications*, Vol. 77, No. 17, 22339-22366, doi: 10.1007/s11042-018-5968-7.

[15] Quan, H., Li, S., Hu, J. (2018). Product innovation design based on deep learning and Kansei engineering, *Applied Sciences*, Vol. 8, No. 12, Article No. 2397, doi: 10.3390/app8122397.

[16] Niu, S., Li, B., Wang, X., Lin, H. (2020). Defect image sample generation with GAN for improving defect recognition, *IEEE Transactions on Automation Science and Engineering*, Vol. 17, No. 3, 1611-1622, doi: 10.1109/TASE.2020.2967415.

[17] Du, Y., Satish Kumar, T.K., Wang, Y.Q., Wang, J.L. (2024). An investigation into multi-stage, variable-batch scheduling across multiple production units, *Journal of Engineering Management and Systems Engineering*, Vol. 3, No. 1, 1-20, doi: 10.56578/jemse030101.

[18] Wang, J., Wang, Z., Qiu, S. (2021). Investigate symmetry, complexity, and screen shapes in interface design aesthetics to promote users' quality perceptions and continuous usage intention of the smartwatch, *International Journal of Human–Computer Interaction*, Vol. 37, No. 20, 1966-1980, doi: 10.1080/10447318.2021.1921366.

[19] Raptis, D., Papachristos, E., Bruun, A., Kjeldskov, J. (2022). Why did you pick that? A study on smartwatch design qualities and people's preferences, *Behaviour & Information Technology*, Vol. 41, No. 4, 827-844, doi: 10.1080/0144929X.2020.1836259.

[20] Wang, J., Xu, C., Zhang, J., Zhong, R. (2022). Big data analytics for intelligent manufacturing systems: A review, *Journal of Manufacturing Systems*, Vol. 62, 738-752, doi: 10.1016/j.jmsy.2021.03.005.

[21] Zhang, Y., Ren, S., Liu, Y., Si, S. (2017). A big data analytics architecture for cleaner manufacturing and maintenance processes of complex products, *Journal of Cleaner Production*, Vol. 142, Part 2, 626-641, doi: 10.1016/j.jclepro.2016.07.123.

[22] Liao, W., Hu, K., Yang, M.Y., Rosenhahn, B. (2022). Text to image generation with semantic-spatial aware GAN, In: *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, New Orleans, USA, 18187-18196, doi: 10.1109/CVPR52688.2022.01765.

[23] Sun, W. (2024). Application of deep learning in digital product design: Product innovation through generative adversarial networks, In: *Proceedings of Second International Conference on Physics, Photonics, and Optical Engineering (ICPPOE 2023),* Vol. 13075, Kunming, China, 531-537, doi: 10.1117/12.3026808.

[24] Feng, J., Zhang, R., Chen, D., Shi, L., Li, Z. (2024). Automated generation of ICD-11 cluster codes for precision medical record classification, *International Journal of Computers Communications & Control*, Vol. 19, No. 1, Article No. 6251, doi: 10.15837/ijccc.2024.1.6251.

[25] Ivanescu, R.C., Belciug, S., Nascu, A., Serbanescu, M.S., Iliescu, D.G. (2022). Evolutionary computation paradigm to determine deep neural networks architectures, *International Journal of Computers Communications & Control*, Vol. 17, No. 5, Article No. 4886, doi: 10.15837/ijccc.2022.5.4886.

[26] Burnap, A., Liu, Y., Pan, Y., Lee, H., Gonzalez, R., Papalambros, P.Y. (2016). Estimating and exploring the product form design space using deep generative models, In: *Proceedings of the ASME 2016 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. Volume 2A: 42nd Design Automation Conference.* Charlotte, North Carolina, USA, Article No. V02AT03A013, doi: 10.1115/DETC2016-60091.

[27] Indrawati, S., Madarja, E.R. (2022). Lean healthcare improvement model using simulation-based lean Six-Sigma and TRIZ, *Mathematical Modelling of Engineering Problems*, Vol. 9, No. 3, 849-855, doi: 10.18280/mmep.090335.

[28] Jiang, F., Huang, J.L. (2025). A decision-making framework for early-stage industrial intelligent engineering innovation based on Extenics and TRIZ, *Journal of Industrial Intelligence*, Vol. 3, No. 2, 88-104, doi: 10.56578/jii030203.

[29] Mihalcea, R., Tarau, P. (2004). TextRank: Bringing Order into Text, In: *Proceedings of the 2004 Conference on Empirical Methods in Natural Language Processing*, Barcelona, Spain, 404-411, Association for Computational Linguistics.