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Mechanical Engineering: Artificial Intelligence as Propeller

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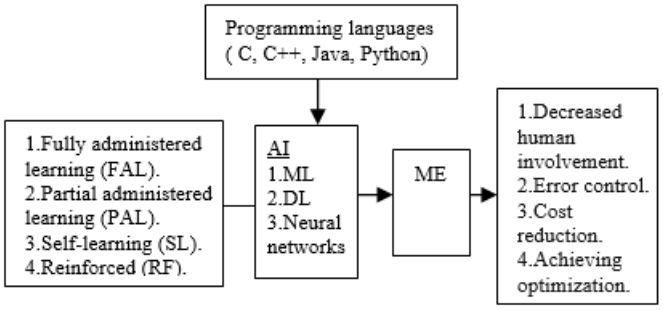
Abstract: ***The aim is to bring to light the role of artificial intelligence-allied areas; and programming languages in mechanical engineering. Core of mechanical engineering is mechanical designs, to develop mean machines for optimized manufacturing of products and services. Impact of mechanical engineering ranges from traditional to high-tech companies. As the world is moving towards automation and modernization; mechanical engineering adopted artificial intelligence (AI). Important programming languages help mechanical engineering use AI to find creative solutions for helping machines for self-learning. To improve learning curve of machines, higher data generation higher is necessary. As the learning curve of machine grows it will take decisions on its own resulting in decreased human involvement, error control, cost reduction and achieving optimization. From long, computer aided designing and computer aided manufacturing are offering automation solutions, artificial intelligence is helping them further enhance their efficiencies involving robotics. Future of mechanical engineering is to move on with artificial intelligence using machine learning and further adopt deep learning and neural networks based on returns on investment.***

Keywords: Artificial intelligence, mechanical engineering, machine learning, deep learning

1. Introduction

Hegemony of human intelligence and involvement in mechanical engineering (ME) field particularly is challenged by artificial intelligence (AI). The process of conceptualization-to-prototype and till manufacturing were the output of human knowledge and creativity in ME specialized area. [6] says AI will replace humans in mechanical engineering field. [3] discussed the importance of AI being used in ME. [9] talks about IT competencies necessary for empowering mechanical engineers to understand and develop automation solutions across ME field. [4] thrown light on how computer technologies including AI are playing role in 'peoples production and life'. [6] views AI has touched many sectors and mechanical engineering too. Today knowledge and creativity, combined with optimization tools are empowering AI to enhance and reduce human involvement. [1] discusses the definition given by Marvin Minsky from 1968 that machines will think and do jobs done by humans, indicating machines will use intelligence from within to do specific task. AI in machine design can save cost with mean designs, and perform in less time leading to better returns on resources. AI is combination of algorithms helping run the cycle of ME for each individual component or machine as a whole with prototypes of virtual nature. Cutting-edge AI tools allow the mechanical engineers to maneuver the process seamlessly and smoothly. This study aim's is to mine literature to support the view that AI will play an important role in upbringing machines on self-learning for delivering optimization. See Figure 1.



2. Literature Review and Discussion

AI will allow mechanical engineers to generate low-cost designs with higher efficiencies. It will also help in controlling the errors at each stage. [2] [13] discussed AI supported real-time applications of ME from shopfloor. [4] says AI gives many solutions to the field of ME. [6] states the revolution of AI has taken over ME from end-to-end process. AI involves in machine learning (ML) and deep learning (DL). ML and DL are data driven [12] [13], hence mechanical engineers have to feed heaps of data for the machines to learn the expectations of mechanical designs. The degree of learning by AI systems directly influences the permutation and combination of solutions for ME. Higher the amount of data feeding to AI, lower are the error rates in designing. AI is driven by complex data processing [14], it takes ME field to higher level of automation [4]. [6] opines AI in ME will improve its performance with infuse of data.

2.1 Artificial Intelligence Categories

Fully administered learning (FAL), partial administered learning(PAL), self-learning(SL) and reinforced (RF) are four categories of AI learning environment [2]. FAL is same as human learning, the learning is done using set pattern of instructions which are known as algorithms inserted into computers. These algorithms when fed with a pattern of design data, they process the data and give back expected

results. In ME area; designs, materials, components, assembly lines, quality checks, proofing errors, trouble shooting and others areas can be algorithmized. [5] in their secondary research discussed more than 30 algorithms useful for optimizing mechanical engineering designs. Patterned data related to design specifications, material details or quality standards in terms of sigma levels if fed into computers, algorithms process data and give the optimized mechanical solutions and further will help in manufacturing the machines in physical form. PAL is where large libraries of mechanical designs data is available for algorithms to involve in self-learning by search, on being fed with limited data, algorithms progress with analytical process to deliver the expected output. SL is superimposition of ocean of algorithms which involves in self-learning to respond with required output for a minimum data input. RF involves in learning maximum permutations and combinations of experiences of mechanical engineers to further be used for generating the required output.

2.2 Machine learning, Deep learning and Mechanical engineering

ML, DL and neural networks are present day goldmines of AI to be explored for gaining optimization, new idea generation and innovations in ME. ML and DL are being used in ME in a range of industrial areas. DL is a sub-division of ML, though DL is comparatively a very high investment tech to that of ML. Algorithms of ML are achievable through a large set of data libraries which can be created within a time and investment limits paving way to be a bankable tech, whereas DL requires a huge investment in terms of time, data, hardware and specific pattern of algorithms, which may make it less feasible from the point of return on investment. Example of DL being a high resource sum can be explained by neural networks which is part of it. Neural networks are creating a virtual human brain, constructing neurons with dendrites, axon, soma, axon terminals for processing information just like human brain functions. As human brain can store data patterns of past with numerous dimensions like shapes, designs, colors, languages, signs, body reflections, reactions of other human/objects, observe natural elements such as patterns of wind, rain, temperature, this list goes endless. Creating neural networks are very complex technologies whose investment recovery in ME will be questioned in corporate boards. [3] in their work discussed similar thoughts on neural networks with details on its architecture, layers, and learning process.

2.3 Programming Languages, Artificial Intelligence and Mechanical Engineering

ML which is more feasible option for ME. ML is well supported by a large array of existing written codes know popularly as libraries. These libraries can be explored in machine designing using a large number of languages as application programming interface (API), means these API can be used as interfacing to utilize the codes for optimizing the resources for machine designing and other areas of ME [8]. There are countless number of libraries available. Libraries come in different categories such as API's provided by operating system, specialized libraries which are area specific like mathematics, video games and so on, programming languages come attached with specific libraries, and other libraries created for proprietary use by firms and individuals.

Python libraries such as Ikpy, Cad in python, Sci-kit, Sympy, Matplotlib, Numpy and numerous many more from different programing languages are very useful for ME. Among the 700 odd programing languages available, there are four important languages useful for ML in ME via., "C", developed in 1970's by Bell labs is a language useful in terms of writing codes for interfacing between machines; also useful in total management of robotics. "C++" is an extension of C, successor is an object-oriented programming with class of objects where each object is a group of related code. It also has large number of libraries for user support. [8] discussed the use of C++ in developing the next gen libraries whose objective is to put elements and its values give possibly large matrices for data processing to be done parallelly.

"Java", developed in mid-1990's by Sun Microsystems is useful in machines especially in robotics. This language with diverse frameworks and libraries is useful in developing applications which enable in monitoring the performance of robotics-oriented machines and control them without direct human intervention. It also helps in scaling up huge data or big data and optimizes cost maneuvering between applications improving the project scalability. There are more advances like "mixed language programming", where interpreter 'Ch' from portable C/C++ integrates with virtual machine of Java leading to "ChJava" with combined features. This gives a better application horizon for ME [11].

"Python", developed in early 1990's by Python Software foundation. It is compatible with easy-to-use user language. Python can be molded for all types of applications; from ME point of view, it is useful in creating real time industrial applications for machines. "MATLAB", developed in mid of 1980's by MathWorks is useful for complex mathematical calculations. It helps in high end computations in vectors and matrices. The later versions added problem solving ability in linear algebra as an add on library. It also has a simulation tool for observing the optimality of any model. It is very popular among large number of global universities across globe to be used by faculty members and students.

2.4 Computer Aided Designing, Computer Aided Manufacturing and Mechanical Engineering

Other than programming languages specialty software's useful for ME such as CAD/CAM, which facilitate virtual designing and manufacturing process. They help in optimizing the entire chain from designing through manufacturing. During 1960's at Renault both CAD/CAM were brought to light. CAD was developed for automating the engineering design process. Further 2D CAD and 3D CAD were released giving opportunity to innovate designs look real-time. CAM enables machine controlling during manufacturing process. Machines are made-up of numerous components and tools; CAM allows to monitor and manage components and tools at individual and integrated levels. Off late AI is deployed in CAD/CAM, if AI is allowed to learn

more at client level, it will help higher self-driving of CAD and CAM systems with him. Several of the libraries available in CAD and CAM can be further used to support new models in ME [8].

2.5 Robotics and Mechanical Engineering

Another important area is Robotics, a multidisciplinary area in which mechanical engineering is the dawn. Starting from design to navigation of the machine and to its performance ME is involved. The first know industrial robot was developed known as "Unimation" in 1950's. Integration of robotics and AI will create synergy for optimization. [3] brings to light the role of ant colony path algorithm useful in developing AI solutions for robots. AI will help robots to perform with very low-level human involvement paving way, to be used in various industries like medical, aerospace, agriculture, manufacturing, nuclear, military and many other related areas. [9] stresses the need for mechanical engineers to involve in learning the intricacies of algorithms, programming languages/API's, CAD/CAM, math models and simulation techniques.

2.6 Industrial applications of Artificial Intelligence in Mechanical Engineering

[7] discussed a real time ME scenario and application of AI into the process of coffee roaster. They identified 'consistency and accuracy' as two important parameters of coffee roaster which can be automated using AI to help employees work with ease and help the coffee roasting process transfer between stages smoothly.

[10] had derived a "Mechanical equilibrium model" to develop artificial rubber-less muscle. There are several parameters which this study investigated. Input pressure, contraction force, contraction displacement. The importance of their study is construction of new model, testing and validation. Such new model development using CAD or other tools leads way to automation/robotics of ME further using AI.

3. Conclusion

In summary it can be articulated that future of ME will deeply integrate with AI inclusive of ML, DL and neural networks. Four languages C/C++, Java, Python and MATLAB will play important role in developing AI solutions for ME. CAD/CAM will continue to play their role in ME, with AI into them enhancing firepower to further offer next gen tools for ME. ML will drive ME further towards automation with robots in large number of areas among different sectors. The future scope of ME lies in ML, in present times DL and neural networks are too ambitious to be considered in terms of investment, returns, risk and acceptability by company boards and governments, but they have bright scope on a mass scale in future.

4. Future Scope

This study has shown the role of AI and its components in ME at a surface level. Several offshoot studies can be derived which focuses on in-depth role of each component of AI in ME. Like role of ML in ME, role of DL in ME using Python. There can be several combinations of studies on AI areas and role of various programming languages in bringing state of the art solutions in ME.

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References

[1] J. Bolter, "Artificial Intelligence," Daedalus. vol.113(3), 1984, p.1–18.
[2] J. Jenis. J. Ondriga, S. Hrcek, F. Brumercik, M. Cuchor, and E. Sadovsky, "Engineering Applications of Artificial Intelligence in Mechanical Design and Optimization," *Machines*. vol.11(6), 2023, p.577.
[3] Y. Chen, "Relevance Research of Artificial Intelligence Technology in the Field of Mechanical Engineering," *World Automation Congress (WAC)*, San Antonio, TX, USA. p.453-457. 2022.
[4] Y, Jiang, "An Analysis of the Relationship between Mechanical and Electronic Engineering and Artificial Intelligence," *International Conference on Virtual Reality and Intelligent Systems (ICVRIS)*, Jishou, China. p.191-194. 2019.
[5] A. Laith, E. Mohamed, and K. Ahmad, "Meta-heuristic optimization algorithms for solving real-world mechanical engineering design problems: a comprehensive survey, applications, comparative analysis, and results," Neural Computing and Applications. vol.34, 2022, p.4081–4110.
[6] M. Bhattacharya, "Mechanical engineering and Artificial Intelligence: The power synergy," The Hindustan Times. **New Delhi.** May 23, 2023. https://www.hindustantimes.com/ht-insight/economy/mechanical-engineering-and-artificial-intelligence-the-power-synergy-101684822882279.html
[7] J. Wibowo, A. Munandar, O. Mahendra, et al, J. Wibowo, A. Munandar, O. Mahendra, J. Josary, D. Ningrum, and B. Sejati. "A review of a smart coffee roaster: electronics, design, and artificial intelligence," Published under license by IOP Publishing Ltd. IOP Conference Series: Earth and Environmental Science, Vol.1116, The 4th International Conference on Agricultural Technology, Engineering, and Environmental Sciences Banda Aceh, Indonesia, August 9-10, 2022.
[8] O. Emil, "Integration of the original software applications for mechanical engineering. IOP Conference Series: Materials Science and Engineering," 916. 012075. Published under license by IOP Publishing Ltd. IOP Conference Series: Materials Science and Engineering, Volume 916, ModTech International Conference - Modern Technologies in Industrial Engineering VIII, Iasi, Romania, 23-27 June 2020.
[9] D. Kurennov, N. Ryzhkova, and Y. Serdyuk, "Formation of IT Competences of Future Mechanical Engineers," ITM Web Conf. 35 01008, 2020.

[10] N. Saito, T. Sato, T. Ogasawara, R. Takahashi and T. Sato "Mechanical equilibrium model of rubberless artificial muscle and application to position control of antagonistic drive system,". Industrial Robot. vol.40(4), 2013. p.347-354.
[11] K. Cheetancheri, and H. Cheng, "Mixed Language Programming in C/C++ and Java for Applications in Mechatronic Systems,". *2nd IEEE/ASME International Conference on Mechatronics and Embedded Systems and Applications*, Beijing, China, p.1-6. 2006.
[12] H. M. Heyn and E. Knauss, "Structural Causal Models as Boundary Objects in AI System Development," *2022 IEEE/ACM 1st International Conference on AI Engineering – Software Engineering for AI (CAIN)*, Pittsburgh, PA, USA, p.43-45, 2022.
[13] T. Vögele, C. Backe, M Bande et al, T.Vögele, C. Backe, M. Bande1, P. Conradi, P. Hovila, K. Kauhaniemi, H. Kumar, T. Kyntäjä, M. Kasari, M. Shafiq, S. Werner, and C.Wiezorek "FUSE – using artificial intelligence in the energy grid of tomorrow," *CIRED 2020 Berlin Workshop (CIRED 2020)*, Online Conference, p.466-468. 2020.
[14] A. B. Kolltveit and J. Li, "Operationalizing Machine Learning Models - A Systematic Literature Review," *2022 IEEE/ACM 1st International Workshop on Software Engineering for Responsible Artificial Intelligence (SE4RAI)*, Pittsburgh, PA, USA, p.1-8. 2022.

Author Profile

Shivank Kokku is currently pursuing semester two, year one B.Tech. Mechanical Engineering from JNTU Hyderabad Campus. Has career interests in Mechanical Engineering, Artificial Intelligence and Robotics. To drive the career interest believes in research as one of the important areas among others in building knowledge portfolio. Invests time in research databases Emerald, IEEE, Sage, ProQuest, Google scholars for research articles and text books. Wrote this paper after giving a thorough readings from these databases, also discussed with faculty members and peers. Has a goal to publish a minimum of six publications in B.Tech, and join research-based M.Tech. program.