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Artificial Intelligence in Mechanical Engineering

Saquib Rouf[1], Moonis Ali[2] , Ali Hussain[3]

[1]Department of Mechanical Engineering, SSM College of Engineering and Technology, Parihaspora, Pattan, Jammu & Kashmir, India
[2,3]Department of Computer Science & Engineering, University of Kashmir, Delina, Baramulla, Jammu & Kashmir, India
khansaquib626@gmail.com[1], moonixali@gmail.com[2], alihussainmeer@gmail.com[3]

ABSTRACT

This paper is a survey based analysis about the applications of Artificial Intelligence (AI) in various domains of mechanical engineering as well as its use in industry and fault diagnostic systems. This paper presents the case for the use of AI instead of conventional techniques in industrial processes and fault diagnosis of mechanical systems as they are time consuming and in some cases ineffective. The use of AI can result in early detection and diagnosis of faults in mechanical systems which can increase the plant safety and can be useful in optimising operational costs. This paper also lists the various uses of an AI driven Knowledge Based System. At the end some diverse applications of AI in mechanical systems have been identified while discussing their positive impact on the field.

Keywords: Artificial Intelligence, Mechanical Engineering, Fault Diagnosis, Knowledge Based System

I. INTRODUCTION

Artificial intelligence is an area of computer science that deals with the simulation of human intelligence processes by machines, especially computer systems. An AI process consists of acquiring information (learning), deducing inferences (by applying logic to reach estimated or definite conclusions), and implementing methods of self-correction over a period of time. Owing to the increasingly vast use of AI across various fields and disciplines applications of AI may range from character recognition and machine vision to natural language processing (NLP) and robotics. Artificial intelligence based algorithms and systems must be given access to various kinds of features, objects, characteristics and relations between them so as to make effective use information and knowledge engineering techniques. However, the process of initiating intelligent reasoning and problem-solving power in machines is a hard and intricate task.

This is where a sub-domain of AI known as Machine learning plays an important role. Learning and acquisition of information without human supervision requires a tremendous capability to identify/classify and cluster patterns across diverse streams of inputs, on the other hand the process of learning with adequate supervision involves classification and numerical regressions. Classification recognises the category that an object belongs to and regression deals with procuring a set of numerical input or output examples, thus enabling the causation of suitable outputs by their respective inputs.

Another sub-domain of AI, Machine perception deals with the capability of a smart AI based system

in making use of sensory inputs to deduce diverse inferences from different subjects of the real-world. Also in an AI system, the discipline of computer vision is responsible to analyse visual-inputs such as facial, object and gesture recognition. Robotics is also a major field attributed to the advancements in AI. Robots require intelligence to handle tasks such as object manipulation and navigation, along with sub-problems of localization, motion planning and mapping. [1]

The main role of artificial intelligence in mechanical engineering is that it makes systems autonomous / automatic. The machines can be made automatic when they are designed to have ability to detect and diagnose errors in manufacturing system [2]. When we have a combined system of mechanical and electronic components, in order to achieve efficiency it is necessary for a system to transfer data quickly from one part of a system to another. This timely transfer of data is done by artificial intelligence. At present, AI is used for diagnosis of mechanical engineering failure [3].

II. APPLICATION OF AI ACROSS VARIOUS METHODS OF DIAGNOSIS IN MECHANICAL SYSTEMS

The main methods for fault diagnosis in mechanical systems by artificial intelligence are:

1. CBR (case based reasoning).
2. RBR (rule based reasoning).
3. FBTD (fault based tree diagnosis).

Based on CBR and RBR an expert fault diagnosis system is prepared whose key members are as follows:

a) User.
b) Man machine interface.
c) Knowledge acquisition system.
d) Reasoning machine.
e) Interpreter.
f) Knowledge process.
g) Case base.
h) Rule library.
i) Data base.
j) Learning system.

Now the working of this system is explained as below:

When the user gives data through user - machine interface, It is acquired by the reasoning machine . This part of the system is programmed by efficient algorithm and hence it provides an expert advice. This input data is saved in the database as a history. Whenever the data is entered by the user, it is checked for a similarity in database in order to take decisions quickly.

A. Intelligent Diagnosis System For Rotating Machinery

Consider an example of fan. Since fan is rotating device therefore it needs a motor. The monitoring parameters are

1. Temperature.
2. Vibrations.
3. Noise.
4. Oil.
5. Performance.

Here universal integrated neural network diagnosis system is used. The core of whole intelligent system is fault diagnosis and decision system.

B. Intelligent Diagnosis System For Reciprocating Systems

Diesel engine is the typical reciprocating system. The fault diagnosis can be done by integrated neural network diagnosis system.

The performance faults of diesel engine can be achieved using a sub – neural network. The input parameters are speed, power, pressure etc . The mechanical fault diagnosis can be achieved by two sub neural networks. Here the integrated neural

network diagnosis system is formed by vibro acoustic signal with oil analysis information as input.

III. AI PRACTICES IN MANUFACTURING INDUSTRY AND APPLIED MECHANICAL ENGINEERING

A. ROLE OF AI IN MECHATRONICS

Mechatronics is a specialised discipline, which is the combination of mechanical, electrical and electronics. In Mechatronics, electrical engineering is associated with study of motors and power system while electronics is related with the study of boards and its control engineering; the mechanical is associated with the hardware apparatus and their controlled movement. The focus of Mechatronics is on robot hardware and its working while AI takes care of software at all level to make it operational and autonomous. It is a field of engineering focused on the design and manufacturing of robots. Robots are often used to perform tasks that are difficult for humans to perform or perform consistently. They are used in assembly lines for car production or by NASA to move large objects in space. More recently, researchers are using machine learning to build robots that can interact in social settings [4]. Nowadays research is done in the field of mechatronics which is specified just on safe and intelligent robots. The methodologies in industrial robotics are based on Automatic control theory [5].

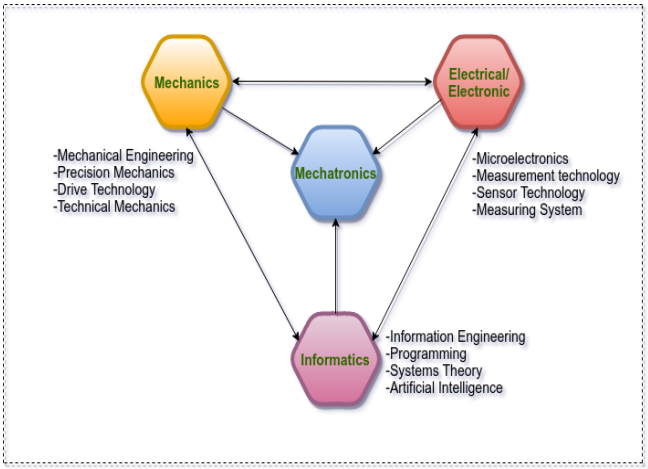

Figure 1. An Overview of Automatic Control Theory in Mechatronics.

B. AI IN MANUFACTURING INDUSTRY

To maintain profitability and high productivity AI is used in manufacturing industries. Machines working with AI can meet the needs of industry and market with better efficiency and reduce the operational costs drastically.

Figure 2, shown below presents an overview to understand the role of AI in manufacturing industry. The interface engine interacts with the knowledge base where the information is pooled along with relevant rules. Information from the knowledge base is applied to real world problems based on the expert system which plays an important role in executing relevant rules after scanning the information from the human interface. Therefore, the AI-Mechanical system can be hugely beneficial in manufacturing industry as it has the power to learn by itself and make amends to the existing rules with the passage of time and human interaction.

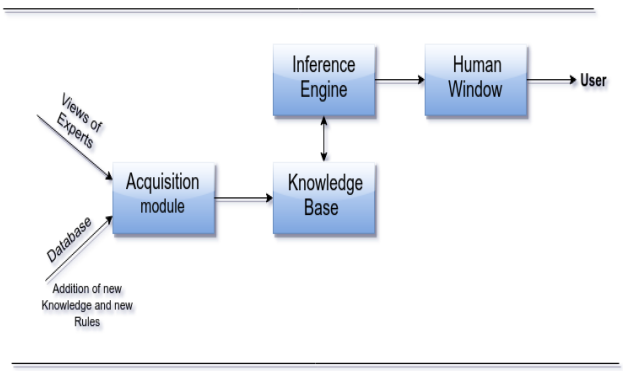

Figure 2. Overview of application of AI in manufacturing industry.

C. AI Driven Decision Making In Knowledge Based Mechanical Processes

An AI driven expert system incorporates the use of Artificial Intelligence in smart decision making which not only improves its performance with time but also makes the system versatile as new rules can be added and modified easily. Since the system is quite dynamic, the languages used to program such systems like LISP or PROLOG can consolidate new changes as the system progresses with continuous human interaction. The Knowledge Based Systems engulf the events from the past and provide

analytical, efficient solutions to real life problems. Some advantages of KBS based AI system are:

1. It reduces risk in a mechanical system i. e it acts as risk manager.
2. It reduces cost of mechanical process by using optimisation techniques.
3. It increases the overall life of an industrial plant by automation of safety systems. It can be used for fault analysis and failure diagnostics.
4. Assessment of surface quality during machining of metals can be easily achieved using AI recognition techniques.
5. It can used for sensor monitoring of tools in unmanned machining process [6].
6. It can be also used in checking the thermal error of machines by using Supervised machine learning techniques. [7].
7. Optimization /planning of metal cutting process can be achieved by AI [8]

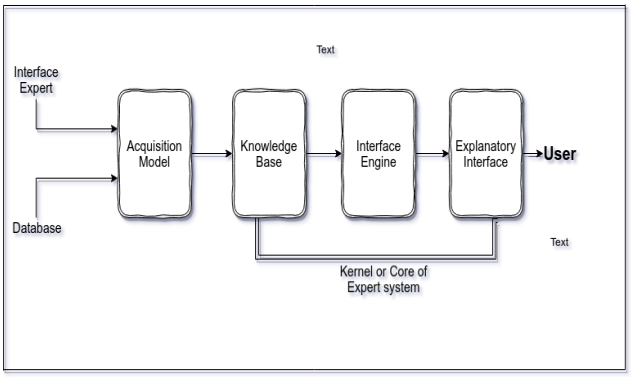

Figure 3. Block diagram of a Knowledge Based System

IV.CONCLUSION

The use of various AI applications and techniques for automation of manual tasks, use of smart methods for diagnostics, pattern recognition and intelligent decision making processes has hugely benefited manufacturing, industrial robotics, as well as fault diagnosis systems amid other allied branches of mechanical engineering. Use of AI not only speeds up conventional mechanical processes but also results in drastic reduction of costs and a surge in efficiency of these systems. With introduction of targeted AI approaches for specific sector based requirements in manufacturing and robotics the scope for this field in the future seems ever more promising.

V. REFERENCES

[1] Production technology by R. k Jain .

[2] https://www.techopedia.com/definition/190/artificial-intelligence-ai

[3] H Yang, J Mathew, L Ma. Intelligent diagnosis of rotating machinery faults - A review [M]. Pattern Recognition & Data Mining, 2002.

[4] http://searchcio.techtarget.com/definition/AI

[5] L. Sciavicco and B. Siciliano. Modelling and Control of Robot Manipulators, 2nd ed. Springer-Verlag, Berlin Heidelberg, 2000

[6] R. Teti, K. Jemielniak, G. O. Donnell , D. Dornfeld ,Advanced monitoring of machining ,CIRP Annals-Manufacturing Technoperationsology, 59 (2010) pp. 717-739

[7] J. Mayr,J. Jedrzejewski,etal, Thermal issues in machine Tool, CIRP Annals-Manufacturing Technology,61(2012),771-791.

[8] I. Mukherjee, P. K. Ray, A review of optimization techniques in metal cutting processes, Computers & Industrial Engineering 50 (2006) 15–34