Machine Learning and Artificial Intelligence

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Abstract Artificial intelligence is a very powerful tool for engineers. Mechatronics can leverage AI and ML to bring revolutionary changes in different domains of this vast subject. Control engineering, robotics and automation, autonomous vehicles, medical devices, quality control, precision agriculture, and remote sensing can all benefit from the implementation of AI and ML. The first part of this chapter will focus on the fundamentals of machine learning, artificial intelligence, and various techniques used in ML, AI, and deep learning. The second part will deal with AI and ML in control systems, robotics, and automation. This chapter will briefly discuss the challenges of implementing AI and ML in mechatronics systems. This chapter focuses on the development of a knowledge of ML and AI approaches utilized in mechatronics engineering.

Keywords Machine learning · Artificial intelligence · Robotics · Supervised learning · Unsupervised learning

1 Introduction

Artificial intelligence (AI) is the aptitude of a computer or robot controlled by a computer capable of performing activities that are frequently linked with the people of intelligence. The phrase is widely used to refer to the attempt of assembling systems that have human-like intellectual processes, such as the reasoning ability, distinguish meaning, or learn from previous encounters. On the other hand, machine learning

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(ML) is a discipline of AI that concentrates on the development and investigation of statistical algorithms that can derive information from data and make inferences from previously unknown data, allowing them to complete tasks without specific guidance. In allowing computers to do tasks that require human supervision traditionally, the fast-developing sciences of artificial intelligence (AI) and machine learning (ML) are changing a variety of industries. AI covers a wide spectrum of technologies, from limited AI, which is best at certain jobs, to the speculative idea of AI, which would be better than humans. Algorithms used in ML, a branch of AI, use supervised, unsupervised, and reinforcement learning approaches to study from data and acquire more accuracy over time. Prediction analytics, driverless cars, tailored corrections, image and voice recognition, and more are uses of ML and AI. But new technologies additionally create significant social and ethical challenges, such as bias, privacy, loss of jobs, and security; therefore, it will take constant work to guarantee the responsible development and application of these advances.

2 Fundamental Concept of Machine Learning

Machine learning is an automated data analysis technique. It is an area of computer science that deals with the automatic finding of patterns in data and, based on these patterns, predicting the future or performing decision-making by applying statistical methods. Machine learning allows a system, without explicitly programming it, to learn from data or examples [1].

2.1 Workflow or Operation of Machine Learning

Before we go for the specifics of Machine Learning (ML), let's have a look at its fundamental methodology. Figure 1 illustrates the workflow of ML process that consists of several integral parts. They are exploration and data processing, training and testing data, modeling, and evaluation.

The model of machine learning is a piece of smart code that is formed by testing and training gathered data. Data gathering is subjected to on the category of projects. Different types of sensors, databases, files, and Internet sources can be used as the main sources of data. After that, the raw data should be cleaned through the data processing method. Then, the analyzers have to design the best possible model to test and train the data appropriately. Finally, the model must be evaluated which is a vital part of the development process of the designed model.

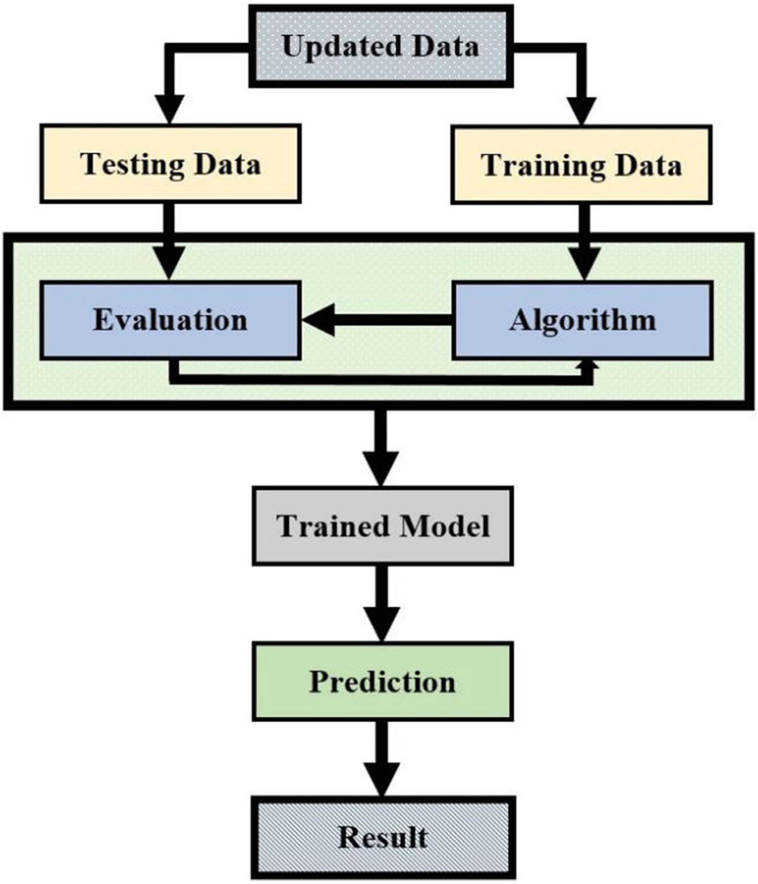

Fig. 1 Workflow of machine learning

2.2 Types of Machine Learning

Machine Learning (ML) is broadly classified into four groups: supervised, semi-supervised, unsupervised, and reinforcement learning [2]. Figure 2 shows the categories of this process.

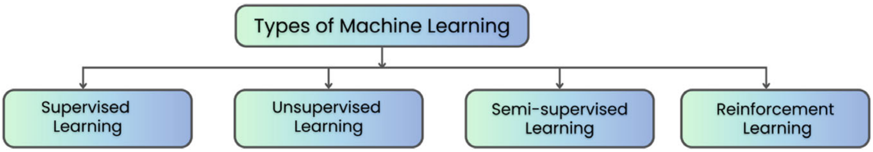

Fig. 2 Types of machine learning

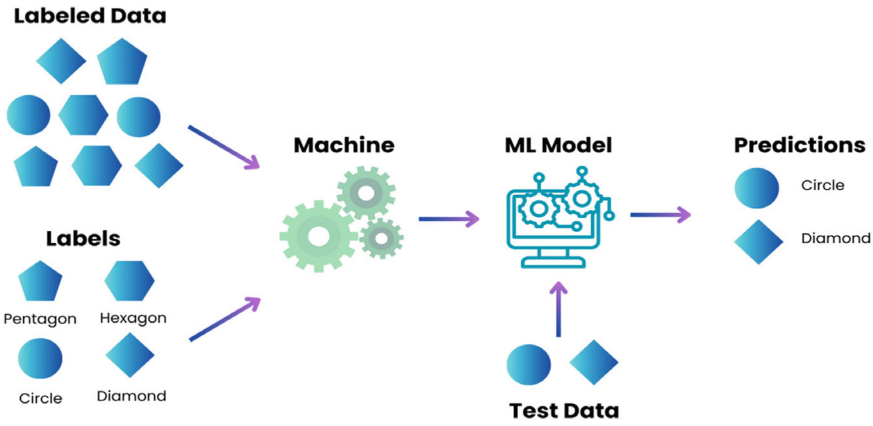

Fig. 3 Supervised machine learning process

2.2.1 Supervised Learning

A subset of ML and AI is supervised learning which is illustrated in Fig. 3. It is significant because it uses labeled data sets for training algorithms in order to sort out data or to forecast outcomes precisely. When we want to build a model, for example, that can identify images of shapes, engineers will feed a data set with labels that include a diverse range of shapes. Depending on the identified outcomes, the algorithm will determine which set of attributes corresponds to each shape. The model can be evaluated by presenting it with a portrait of a shape and asking it to identify the shape. If the model returns an improper response, we may keep training and changing its parameters with new instances to develop accuracy and diminish faults.

Supervised learning can be of many different kinds, such as linear regression, Naive Bayes, neural networks, logistic regression, SVM, K-nearest neighbors, random forests, and many more [3].

2.2.2 Unsupervised Learning

This kind of machine learning uses algorithms to evaluate and cluster unlabeled data sets. These algorithms identify several hidden patterns or data groups without human involvement. Unsupervised machine learning models, unlike supervised machine learning, are given unlabeled data and are allowed to discover insights and patterns without obvious guidance or instruction. Figure 4 demonstrates this type of machine learning process. The main functions of this method are association, clustering, and dimensionality reduction [4]. There exist three distinct categories of unsupervised learning methodologies: Clustering, Dimensionality, and Association. Clustering is the process of organizing data into meaningful groups. Dimensionality reduction is

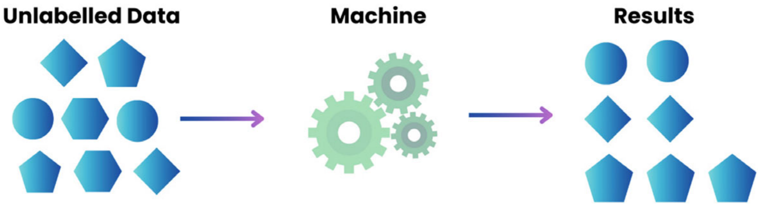

Fig. 4 Unsupervised machine learning process

the process of representing high-dimensional data with a lower number of dimensions. Association refers to the process of identifying the associations between variables within a large data set. Clustering refers to the process of grouping similar items or data points together based on their characteristics or attributes. Clustering occupies a prominent position. This technique uses a clustering algorithm to organize the data by identifying patterns.

One common real-world application of the approach is to group clients that share similar traits. Dimensionality reduction techniques aim to create a lower-dimensional representation of high-dimensional data. This technique is crucial because handling data with a large number of dimensions is challenging for both humans to read and machine learning algorithms to learn patterns from. This technique is frequently employed during the pre-processing stage of data, as intricate input material is condensed to its most valuable and informative components.

For example, we imagine that we have a large weather data set. An algorithm of the unsupervised learning will endure the data set to recognize patterns in the points. Currently, the most commonly used unsupervised learning algorithms are k-means clustering, fuzzy means, hierarchical clustering, and partial least squares [5].

2.2.3 Semi-Supervised Learning

Semi-supervised learning is one kind of ML that uses both unlabeled and labeled data to train AI models to classify and for regression problems. It consists of a few of labeled examples and a lot of unlabeled samples [6]. This method sits between supervised learning and unsupervised learning. They are especially useful in some cases when acquiring enough labeled data is excessively challenging or expensive, yet big volumes of unlabeled data are easy to obtain. In such states, neither fully supervised nor unsupervised learning methods are appropriate.

Transductive learning, co-training, and self-training are a few of the methods utilized in semi-supervised learning [7]. In this scenario, self-training employs a supervised learning algorithm-trained model on labeled data to forecast labels for unlabeled data. Once we add the most accurate forecasts to the set of training variables, we retrain the model using this enhanced data set. A machine learning pipeline intended for prediction and classification is depicted in Fig. 5. First, characteristics are retrieved and optimized from labeled data. K-means clustering is used to extract

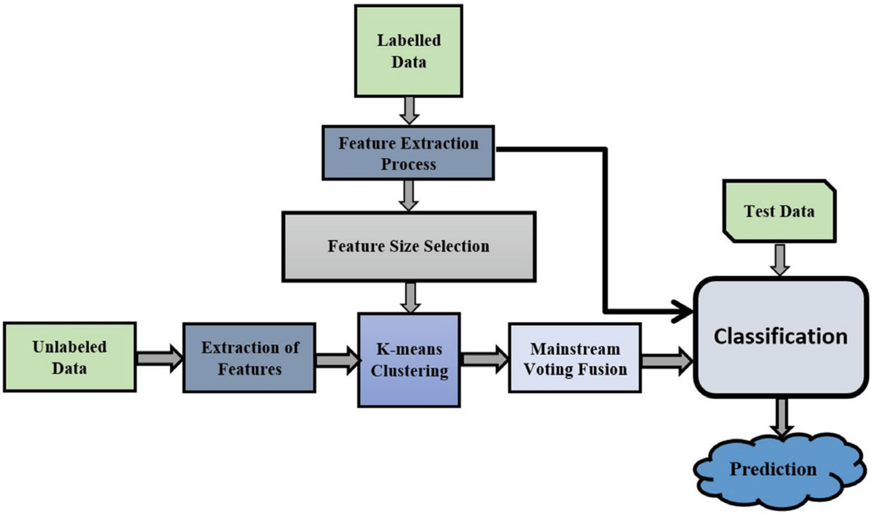

Fig. 5 Semi-supervised learning

features from unlabeled data concurrently. To improve accuracy, mainstream voting fusion is used to merge the clustering results. The classification model receives input from both the clustered unlabeled data and the processed labeled data. In order to ensure correct results, test data is finally identified and used to make predictions. This is done by using the trained model. For reliable prediction, our integrated method effectively handles both labeled and unlabeled data.

2.2.4 Reinforcement Learning (RL)

RL is a segment of ML that enables an AI-powered system (also known as an agent) to obtain knowledge via trial and error based on feedback from its previous actions. This feedback is either positive or negative, communicated as a reward or penalty, and its aim is to maximize the reward function. RL learns from its errors and provides AI that nearly resembles natural intelligence as is now achievable. Figure 6 demonstrates the total phenomena of the reinforcement learning process. In terms of learning approaches, RL is comparable to supervised learning in that it involves input–output mapping, but that is all they have in common.

Feedback directs the agent in supervised learning to the proper set of behaviors to implement. The agent determines how to do the assignment appropriately. Compared to unsupervised ML, RL has distinct objectives. The objective of unsupervised ML is to identify similarities and contrasts between data points. The purpose of RL is to develop the best action model to maximize the overall reward for the RL agent. In the absence of a training data set, the agent solves the RL issue using its own behaviors and environmental information.

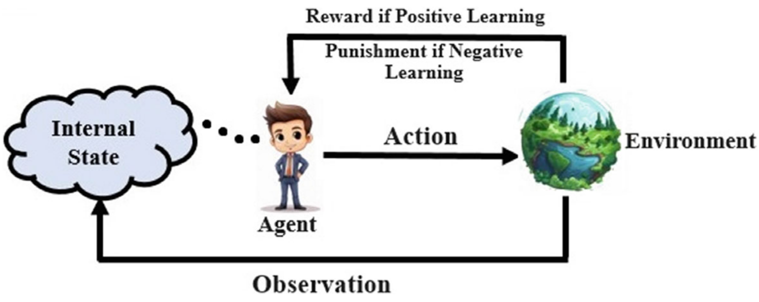

Fig. 6 Reinforcement learning

3 Evolution from Machine Learning to Artificial Intelligence

From its origins in machine learning (ML), an essential component that focuses on creating algorithms that allow computers to train from and take decisions depending on data, AI has seen substantial evolution. To create a framework for increasingly sophisticated AI systems, machine learning initially focused on identifying patterns and making data-driven predictions. The development of machine learning (ML) techniques, such as artificial neural networks and deep learning, allowed them to be more comparable to human cognitive procedures, which prepared the way for the expansion of AI applications. As a result of this development, artificial intelligence has been able to expand its applications beyond limited, specific tasks to include natural language processing, autonomous systems, and sophisticated problem-solving. Thus, the convergence of ML and AI has contributed to the creation of ever more intelligent systems that can carry out a broad range of tasks that are comparable to humans.

4 Application of ML, AI, and DL

4.1 Enhancement of Predictive Maintenance with Artificial Intelligence

A condition-based maintenance strategy guides the work of predictive maintenance (PdM). It includes maintaining a check on the tool's operational characteristics, evaluating operational data or performance, identifying potential problems, and addressing them before the equipment malfunctions [8]. Figure 7 illustrates the framework of the predictive maintenance process.

Facility maintenance and operations are characterized as the regular activities, functions, and manpower necessary to run and sustain a facility asset, ensuring that

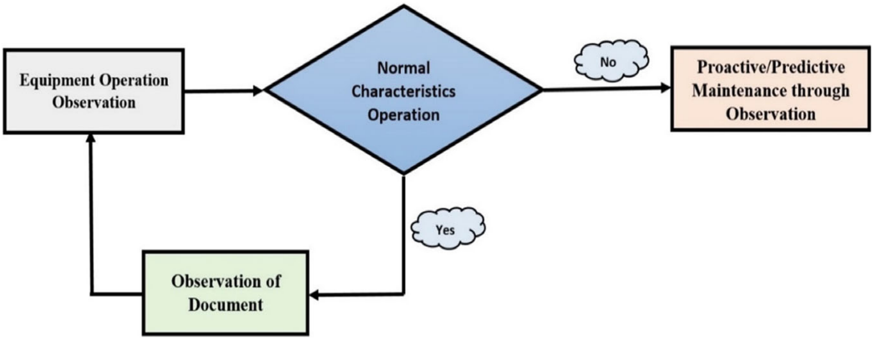

Fig. 7 Predictive maintenance framework

its purpose is available for the basic use and the functions are preserved over the life of the facility. Administrations, facilities, management experts, and patrons spend a lot of money each year to execute this duty. Scarce amount of facility operations is responsible for a major amount of the costs, which we can ignore. In this case, we may use AI in combination with prognostic maintenance in order to reduce operating and maintenance costs. The core concept of predictive maintenance is AI's ability to deliver unbiased investment and repair suggestions based on analyzed data set. A facility operations program cannot completely integrate AI owing to a scarce of data [9].

4.2 Applications of AI in Facility Management and Predictive Maintenance

AI enables real-time monitoring process and operational features of awareness of the facility. Unbiased and data-driven facility system maintenance, investment, and decisions. AI in the facility operations software collects, analyzes, and interprets data based on learnt features, then predicts based on the interpreted data.

4.3 Increase Facility System Online Time

Incorporating AI into the facility operations skill of a facility management program has the ability to boost facility system uptime. Predictive maintenance permits the surveillance and inspection of facility system operations for minor deviations, the resolution of issues before they become significant, and the smooth running of the facility [10]. Maintenance workers often plan and schedule equipment downtime during off-peak hours to avoid interrupting or disrupting existing operations, which is an advantage of predictive maintenance provided by artificial intelligence [11].

4.4 Smart Energy Management System

AI models estimate load profiles and energy consumption, as well as resource scheduling, to ensure efficient use of energy resources and consistent performance. AI is used in a variety of smart energy management applications, such as energy generation forecasting [5, 8, 9], demand forecasting [9, 12], demand side management, optimized energy storage operation, energy pricing prediction, weather phenomena related to energy predictions [9], energy theft detection, predictive maintenance and control [12], and building energy management [13]. Artificial intelligence models may be used in solar, geothermal, wind, hydro, ocean, hydrogen, bio, and hybrid energy [14]. The transformative power of AI provides several upsides to the energy industry. It reassembles the process of generation and delivery of energy. Figure 8 demonstrates the uses of AI in the field of energy sector, for energy management, and how the whole energy segment is digitalized.

AI models include wavelet neural networks (WNNs), artificial neural networks (ANNs), support vector machines (SVM), hybrids, decision trees, and ensembles. Hybrid ML models are often quicker, more precise, and simpler to use [9, 15]. Current

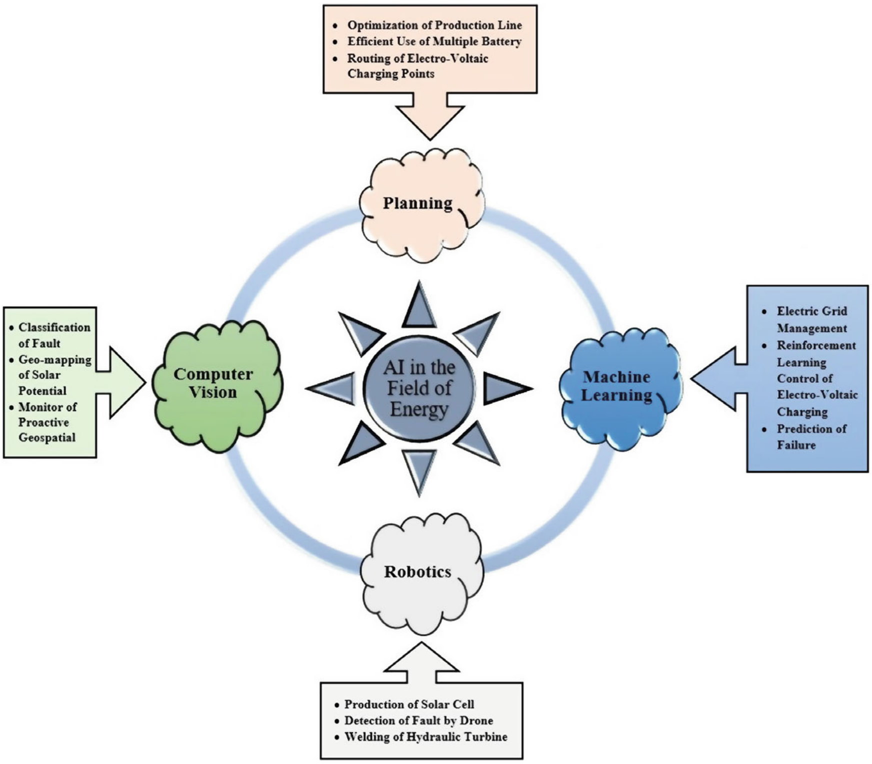

Fig. 8 Usage of AI in energy sector

and projected future energy management developments include the use of hybrid and multi-stage intelligent algorithms for energy forecasting and resource control [15].

4.5 Robotics and AI (RAI) in Case of Offshore Wind Sector

RAI are being utilized to remove lifetime service constraints and enhance beneficial and sustainable offshore wind energy production. Today, engineers employ RAI programs to help them accomplish short-range goals in operations and maintenance. In order to move forward, RAI can play an important role in the whole lifetime of offshore wind infrastructure, including surveys, planning, design, operational support, logistics, training, and discharging. The global need for clean and sustainable energy sources is a major driving force behind the progress of wind turbine design. Figure 9 highlights the economy circle of robotics and AI for a synergetic and sustainable offshore wind segment. Generally, wind farm operators use technical skills and innovative AI algorithms to guide wind turbine and wind farm design [16].

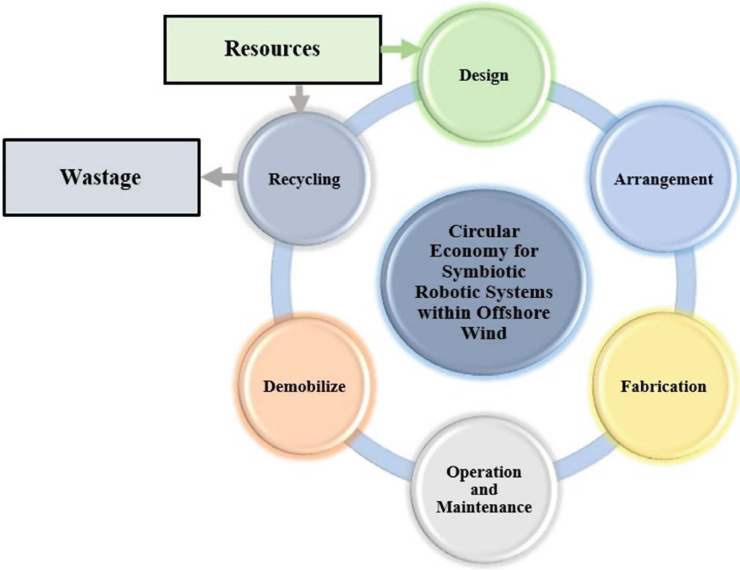

Fig. 9 RAI circular economy for a sustainable and symbiotic offshore wind sector

4.6 Application of AI and ML in Robotics

Machine learning and artificial intelligence are relatively recent developments. They are evolving, reaching new heights, and significantly enhancing their abilities. AI and machine learning can significantly improve robotics applications such as image recognition, navigation, prediction, and manufacturing. AI and machine learning have the potential to revolutionize robotics through enhanced image identification, navigation, anticipation, collaboration, and production ability. The autonomy of a robot in an environment is divided into three distinct groups: perception, planning, and execution. The basic objective of merging robots with AI is to achieve maximum autonomy via learning. It is reasonable to suppose that intelligence is defined by the ability to predict the future while arranging a task or engaging with the outside world.

AI plays a crucial role in perception in the field of robotics. Robots may use computer vision or integrated sensors to detect their environment. Over the past 10 years, computer systems have improved their vision and sensing capabilities. Not only is vision important for planning, but it also helps the robot develop a false feeling of self-awareness. This allows for interactions between the robot and other things in the same environment. This discipline is referred to as social or community robotics. It divides into two types: human–robot interfaces (HCI) and cognitive robotics. HCI seeks to improve the robotic perception of people in areas like activity understanding, emotion recognition, nonverbal communication, and environment navigation alongside humans [12, 17]. The ultimate goal of cognitive robotics is to enable robots to learn and acquire knowledge independently from complex levels of perception by imitation and experience [13, 18]. It tries to replicate how experience and use of sensor manage the human cognitive system, which governs the process of acquiring knowledge and comprehending [19]. Furthermore, there are approaches for cognitive robots that leverage curiosity and incentives to improve the quality and pace of information acquisition via learning [14].

Artificial intelligence has continued to break all past records and overcome various challenges that were unbearable less than ten years ago. These advancements, when combined, will continue to alter how we think about robotic intelligence in a range of new sectors. Furthermore, in March 2019, Xinhua News Agency that is controlled by the Chinese government has announced the introduction of their newest AI news presenter, a female-gendered scheme dubbed Xin Xiaomeng [10, 20]. According to AI Applications, enormous amounts of data must always be processed in order to explore and find space. AI and ML are the most effective ways to manage and handle such large amounts of data. After doing considerable research, scientists discovered a distant solar system with eight planets by using AI to comb through several years of data. Kepler telescope was used to record the data. Self-driving cars have long been a buzzword in the field of artificial intelligence. The arrival of self-driving cars will surely revolutionize the transportation sector. Some businesses, such as Waymo, have tested the first AI-driven public ride-hailing service [20, 21].

4.7 AI and Robotics in Healthcare

AI is becoming progressively capable of performing human-like tasks more effectively, swiftly, and affordably. Robotics and AI have enormous potentiality in healthcare. They are becoming increasingly integrated into our healthcare ecosystem, just as they are in our daily lives. Eight ways to showcase the transformation of healthcare system via AI and robotics have been highlighted in Fig. 10. AI is helping people to stay healthy and fit through health applications. Besides, the specialists can detect and diagnose fast to make an early decision, to provide treatment, and the end of life has been approached.

Elderly people are more comfortable with home assistance robots because they are more open to mobile devices. Robots can perform household tasks and basic daily operations. Smart houses, service robots, and intelligent agents help senior citizens with daily tasks. This allows them to live freely and without invasive activities for as long as possible. IoT, cloud-enabled services, and AI will be examples of enabling technology [22]. The COVID-19 pandemic and the Ebola outbreak have revealed numerous applications of robotics [23]. As the use of robotic surgery grows, more surgeons are beginning their careers with it. Furthermore, an increasing number of residencies include robotic surgery in their basic training. Competency-based robotics training programs have been created. We included them in the training of

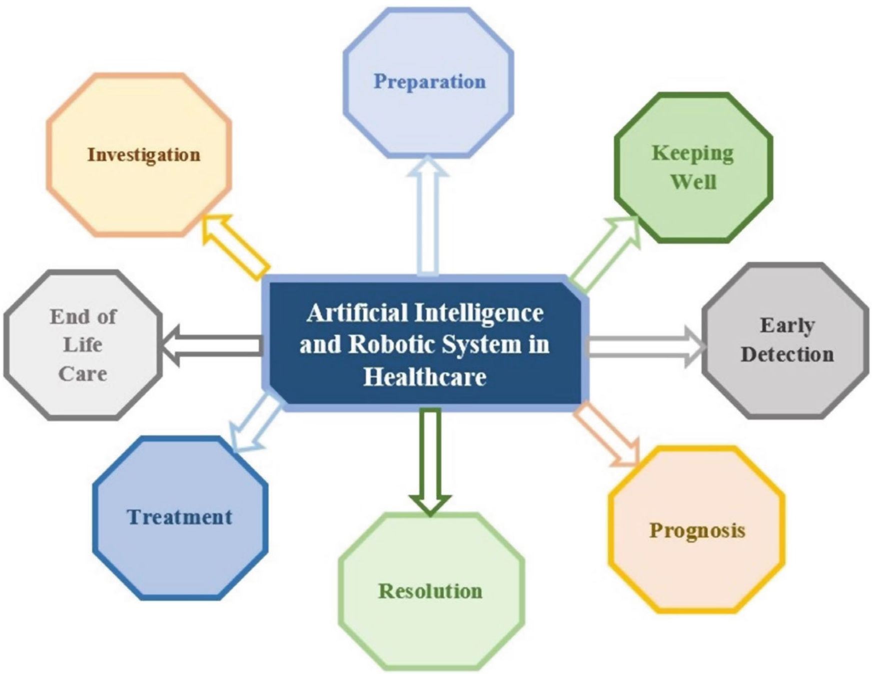

Fig. 10 AI and robotics in healthcare system

surgical oncology fellows. The findings revealed that the fellows could effectively accomplish sophisticated robotic gastrointestinal operations following training and utilize their newly acquired skill set after graduation.

According to studies comparing open versus robot-assisted laparoscopic surgery (RALP) for prostate cancer, patients who chose the latter had better mean educational levels, despite an approximately 30% increase in operation expenses. In terms of consequences, researchers connected the open technique to a greater probability of thromboembolism, while RALP was related to a lower rate of transfusion and a shorter time. A mathematical model was proposed as a result of research on the application of robots in surgery. SARA, a system for socially assistive robotics (SAR), is currently being developed. The system's goal is to give an automatic health monitoring system and support to elderly persons who have modest cognitive impairments. SARA's challenges include security, privacy, reliability, data interoperability, IoT network management, and device. The system supports robot activity (RAS). Robotic surgery can reduce surgery time while improving surgical workflow efficiency. Robots help to adjust workflow and execute procedures on various body regions. Robotic surgery advances image processing using neural networks, as well as the digitalization of radiography and pathology. It allows for precise motions during bi-manual operation, with articulated arms and a 3D magnified perspective. However, the effectiveness of robotic surgery is dependent on the quality of the data given. Despite this, the healthcare business still has privacy issues. Surgeons can get useful insights from the information communicated and obtained during surgery. Standard diagnostic techniques include brachytherapy, breast biopsies, and prostate biopsies. We can perform these treatments using robotic percutaneous needle applications guided by ultrasonography [24]. We recommend the use of robotic machinery since these scenarios necessitate a certain degree of hand dexterity. The technology's use enhances the accuracy of doubtful tissue identification. It allows for the removal of a biopsy through small lesions. Similarly, human physicians can use robots in MRI-guided treatment to mimic the physical two-point grasping motion. A robotic system can carry out small-scale manipulation tasks that involve human judgment, sensory integration, and hand–eye coordination. We call it a steady-hand micromanipulation system [13]. This allows the operator's hand to handle surgical tools alongside a specially designed robot arm.

Medical imaging has become an essential component of healthcare over the last few decades. Imaging or image processing is widely used for illness treatment, diagnosis, verification, and rehabilitation. Doctors examine digital medical pictures from several sources, including retinal photography, mammography, morphology slides, histology, ceroscopy, computed tomography (CT), ultrasound (US), magnetic resonance imaging (MRI), and positron emission tomography (PET) scans. Data about diagnostic imaging modalities and their most common applications is available. Scientists aim to apply methods from deep learning to a number of healthcare jobs. Some of these activities include classification, lesion detection, area of interest (ROI) segmentation, registration, image generation, image quality enhancement, and integrating image data with clinical reports to provide a written report based on image analysis. In this example, we focus on applications and different approaches to addressing the stated issues in various anatomical locations, such as the brain, eye, chest, breast, heart, and abdomen [25–28].

MRI has a high spatial resolution and is essential for analyzing brain anatomy, whereas AI models for neuroscience studies mostly concentrate on MRI. Other modalities with inferior contrast decisions, like CT and resting-state fMRI, have fewer models. As a result, radiologists prefer T1W MRI over other modalities when performing 3D sequences. However, the use of AI analysis and automatic analysis of lesions would greatly benefit patients and experts.

The primary goals of thyroid gland research are to detect malignant illness in thyroid nodes and forecast lymph metastases. Researchers employ artificial intelligence to improve the TI-RADS risk rating for thyroid nodules. The primary areas of study on the thyroid gland are the detection of malignant illness in thyroid nodes and the prediction of lymph metastases. Researchers employ artificial intelligence to improve the TI-RADS risk rating for thyroid nodules. Swallowing creates movement artifacts, so MRI is ineffective, and US has limited sensitivity for identifying lymph node invasion. Some researchers created an automated approach for recognizing thyroid and neck tissues in ultrasonography using a deep learning architecture [29].

The primary drawback of the lymph node research was that, like previous AI studies, the authors regarded each node as a distinct instance in order to expand the size of the training data set. With this strategy, the model may get over-trained to predict specific tumor types that misestimate more frequently. Because ophthalmology uses diagnostic images extensively, the corresponding AI models require preoperative planning and diagnosis. The researchers are now exploring the potentiality of AI in dry eye disease screening to identify the challenges and future research directions [28]. Machine learning mainly enhances ophthalmology by improving the accessibility associated with the diagnosis at a very low cost [30, 31].

X-ray mammography is one common subject of AI research in computer vision medicine. There are two main reasons for this. First, screening for breast cancer often involves the use of breast X-rays. Secondly, this approach has a low detection rate for soft tissue disease. Researchers frequently make the approach more sensitive to the disease's early stages. First, screening for breast cancer often involves the use of breast X-rays. Secondly, this approach has a low detection rate for soft tissue disease. Researchers typically make the approach more sensitive to early illness stages. Despite the effectiveness of US as a breast cancer screening tool, the primary purpose of US-based AI solutions is to predict the condition of lymph nodes or detect their metastases. Because it's a useful diagnostic tool, new research uses MRI mammography data to feed machine learning algorithms because it's a useful diagnostic tool as well.

The amount of research on using CT to identify lung cancer is increasing. Figure 11 demonstrates the forecast of lung cancer through artificial intelligence. Besides, AI methods enable automatic pulmonary node detection and differentiation between benign and malignant nodes. One common shortcoming of the systems is that they lack the ability to differentiate between pathologies that warrant differential diagnosis and lung cancer. For example, we were unable to develop an AI method for sarcoidosis detection. If we were to build one, it would greatly benefit pulmonology. Using AI

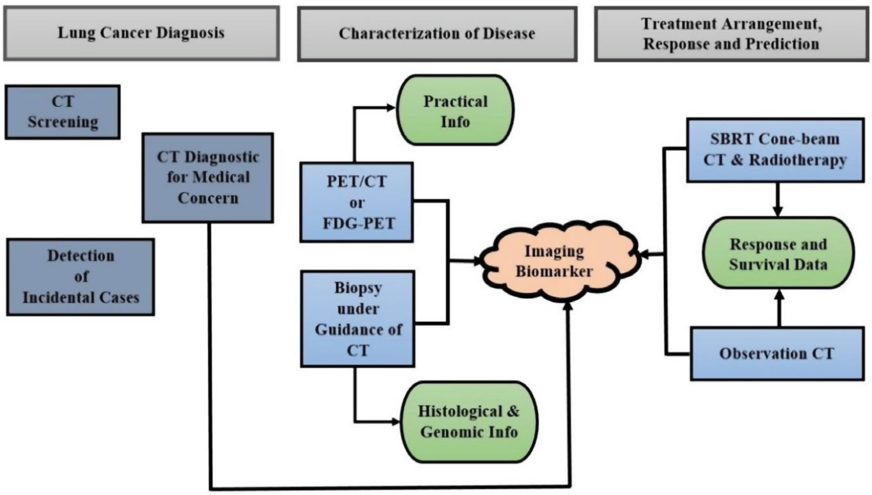

Fig. 11 Lung cancer prognosis by using AI

to diagnose pulmonary tuberculosis is one area of application. One common issue is that data scientists mostly work with 2D images (CXR) due to data availability, despite their low informative value. Chest CT scans, which are far more sensitive and frequently performed on patients, inspire a few models. Machine learning techniques for detecting COVID-19 emerged shortly after the outbreak. By using lung CT appearance to deliver sensitive diagnoses, they assist medical professionals in differentiating between community-acquired pneumonia and COVID-19.

Moreover, artificial intelligence provides several solutions for the abdominal cavity. The abdominal cavity radiology includes fat tissue and models of segmentation to evaluate the volume of inner organs and classify models for a radiation response prediction qualitatively [13].

5 Conclusion

To conclude, this chapter provides an informative investigation into the fields of AI and ML. The fundamental concepts that underpin these technologies have been investigated here. The range of the investigated technology ranged from the fundamental principles of learning algorithms to the intricate designs of neural networks. Through case studies and examples, we have seen the revolutionary impact of AI in a variety of disciplines, including healthcare, finance, and transportation. However, as we delight at the ability of a robotic body to develop and adjust, we must equally consider the moral and social impacts of this rapid expansion. Questions of prejudice, privacy, and job displacement loom big and need serious study and ethical management by everyone involved. Moving into the future, the next phase of AI and ML has great potential. However, it also poses substantial barriers. It is vital to negotiate this terrain with caution and foresight, using the potential of new technologies to generate positive change while avoiding unexpected effects. With a careful and collaborative approach, we can harness AI's transformational capacity to create a more sustainable and prosperous future for everyone.

References

1. Roque AS, Krebs VW, Figueiro IC, Jazdi N (2022) An analysis of machine learning algorithms in rotating machines maintenance. IFAC-Papers OnLine 55(2):252–257
2. Fahle S, Prinz C, Kuhlenkötter B (2020) Systematic review on machine learning (ML) methods for manufacturing processes–identifying artificial intelligence (AI) methods for field application. Procedia CIRP 93:413–418
3. Tarik M, Jebari K (2020) Maintenance prediction by machine learning: study review of some supervised learning algorithms. In: Proceedings of the 2nd African international conference on industrial engineering and operations management. IEOM Society International, Harare, Zimbabwe
4. Samuel OW, Asogbon MG, Geng Y, Al-Timemy AH, Pirbhulal S, Ji N, Li G (2019) Intelligent EMG pattern recognition control method for upper-limb multifunctional prostheses: advances, current challenges, and future prospects. Ieee Access 7:10150–10165
5. Bengio Y, Courville A, Vincent P (2013) Representation learning: a review and new perspectives. IEEE Trans Pattern Anal Mach Intell 35(8):1798–1828
6. Zhang D, Lee WS (2004) Learning to integrate web taxonomies. J Web Semant 2(2):131–151
7. Wang Z, Li T, Zheng JQ, Huang B (2022) When cnn meet with vit: towards semi-supervised learning for multi-class medical image semantic segmentation. In: European conference on computer vision, pp 424–441. Springer Nature Switzerland, Cham
8. Lei Y, Yang B, Jiang X, Jia F, Li N, Nandi AK (2020) Applications of machine learning to machine fault diagnosis: a review and roadmap. Mech Syst Signal Process 138:106587
9. Theissler A, Pérez-Velázquez J, Kettelgerdes M, Elger G (2021) Predictive maintenance enabled by machine learning: use cases and challenges in the automotive industry. Reliab Eng Syst Saf 215:107864
10. Paleczek A, Grochala D, Rydosz A (2021) Artificial breath classification using XGBoost algorithm for diabetes detection. Sensors 21(12):4187
11. Scaife AD (2023) Improve predictive maintenance through the application of artificial intelligence: a systematic review. Results Eng 101645
12. Burduk A, Chlebus E, Nowakowski T, Tubis A (2018) Advances in intelligent systems and computing intelligent systems in production engineering and maintenance, vol 835. Available: http://www.springer.com/series/11156
13. Habuza T, Navaz AN, Hashim F, Alnajjar F, Zaki N, Serhani MA, Statsenko Y (2021) AI applications in robotics, diagnostic image analysis and precision medicine: current limitations, future trends, guidelines on CAD systems for medicine. Inform Med Unlocked 24:100596
14. Oudeyer PY, Smith LB (2016) How evolution may work through curiosity-driven developmental process. Top Cogn Sci 8(2):492–502
15. Li J, Herdem MS, Nathwani J, Wen JZ (2023) Methods and applications for artificial intelligence, Big Data, Internet of Things, and Blockchain in smart energy management. Energy AI 11:100208
16. Mitchell D, Blanche J, Harper S, Lim T, Gupta R, Zaki O, Flynn D (2022) A review: challenges and opportunities for artificial intelligence and robotics in the offshore wind sector. Energy AI 8:100146

17. Ran Y, Zhou X, Lin P, Wen Y, Deng R (2019) A survey of predictive maintenance: systems, purposes and approaches. arXiv preprint arXiv:1912.07383.
18. Soori M, Arezoo B, Dastres R (2023) Artificial intelligence, machine learning and deep learning in advanced robotics, a review. Cogn Robot
19. IEEE Staff and IEEE Staff, 2010 international conference on computational intelligence and software engineering
20. Mihret ET (2020) Robotics and artificial intelligence. Int J Artif Intell Mach Learn (IJAIML) 10(2):57–78
21. Bonaccorsi M, Fiorini L, Cavallo F, Saffiotti A, Dario P (2016) A cloud robotics solution to improve social assistive robots for active and healthy aging. Int J Soc Robot 8:393–408
22. Dubey AK, Kumar A, Kumar SR, Gayathri N, Das P (eds) (2021) AI and IoT-based intelligent automation in robotics. John Wiley & Sons
23. Bhaskar S, Bradley S, Sakhamuri S, Moguilner S, Chattu VK, Pandya S, Banach M (2020) Designing futuristic telemedicine using artificial intelligence and robotics in the COVID-19 era. Front Public Health 8:556789
24. Mao Y, Zhang H, Xu N, Zhang B, Gou F, Zhu JK (2013) Application of the CRISPR–Cas system for efficient genome engineering in plants. Mol Plant 6(6):2008–2011
25. Mavridis N (2015) A review of verbal and non-verbal human–robot interactive communication. Robot Auton Syst 63:22–35
26. Xu W, Huang J, Wang Y, Tao C, Cheng L (2015) Reinforcement learning-based shared control for walking-aid robot and its experimental verification. Adv Robot 29(22):1463–1481
27. Horst C, O'Shea R, Goh V (2022) Lung cancer characterization and prognosis: the role of artificial intelligence. Artificial intelligence in cardiothoracic imaging. Springer International Publishing, Cham, pp 471–481
28. Deutsch I, Erel H, Paz M, Hoffman G, Zuckerman O (2019) Home robotic devices for older adults: opportunities and concerns. Comput Hum Behav 98:122–133
29. Ma L, Tan G, Luo H, Liao Q, Li S, Li K (2022) A novel deep learning framework for automatic recognition of thyroid gland and tissues of neck in ultrasound image. IEEE Trans Circuits Syst Video Technol 32(9):6113–6124
30. Armstrong GW, Lorch AC (2020) A (eye): a review of current applications of artificial intelligence and machine learning in ophthalmology. Int Ophthalmol Clin 60(1):57–71
31. Wang MH, Xing L, Pan Y, Gu F, Fang J, Yu X, Liu W (2024) AI-based advanced approaches and dry eye disease detection based on multi-source evidence: cases, applications, issues, and future directions. Big Data Min Anal 7(2):445–484