Artificial Intelligence in Simple Machine Optimization and Application of Automation

Jingcong He*

Department of Computing and Communications, Lancaster University, Lancaster, UK

*Corresponding author: hej18@lancaster.ac.uk

Abstract. With the advancement of technology and the growing demands of modern society, devices using simple machinery are facing more difficult working conditions. They must also meet stricter performance requirements. At the same time, operational negligence by workers can lead to inefficiencies. As a result, traditional simple machines often struggle to complete tasks accurately and reliably. Artificial intelligence (AI) has become a major trend in modern technology. It offers new solutions to optimize and automate simple machinery. This paper introduces the basic concepts and daily applications of simple machinery. It also reviews the development of AI and its role in mechanical automation. Real-world examples are analyzed to show how AI improves the performance and reliability of simple machines. The paper further discusses the problems traditional machines faced before AI integration. It summarizes how AI has helped to solve these challenges. The growing importance of AI in the automation of mechanical systems is demonstrated.

Keywords: Artificial intelligence; simple machine; optimization; automation.

1. Introduction

As technology develops and the demands of humans are getting higher and higher, machines are facing more and more complex environments and increasingly precise requirements to work. It's difficult for machines to deal with such a hard situation without any outside help. And problem arises, machines without intelligence always work loosely and repeat orders time and again, which is inefficiency and low precision, and the demand for precision, stability, and reliability is getting higher and higher. Simple machines fail to satisfy the current environment. However, with the assistance of artificial intelligence and computers, simple machines can address such a problem through basic functions of calculation, judgment, response, and memorization. What's more, dealing with symbols and so on is also an advantage of AI and computers. All the above can simulate the intelligence of humans and realize advanced intelligence such as apperceive, learning, decision making, and so on. People decide to choose artificial intelligence and computer science as the solution. Because AI is based on a symbolic system and processing of information, and makes the human brain have a new mechanism model. And AI could make machines act wisely and flexibly according to what environment they are in. Artificial intelligence has been developed by humans since 1956, when it was created by John McCarthy, to automate processes that need intelligence of human intelligence and create intelligent systems [1]. There are some famous artificial programs like Deep Blue, AlphaGo, and Watson, which are gaining public attention. It has been developed over 70 years and has experienced such a huge change, from symbolic AI and knowledge model to machine learning and high-ranking applications [1]. Trends in the future of artificial intelligence, such as cyborgs, man-machine coexistence, and programming of biology, place artificial intelligence in the technological singularity realm [1]. Whatever which states it has been, it all shows us huge contributions across different fields that artificial intelligence has made and revolutionizes human communication and shapes future opinions potentially [1]. This evolution of artificial intelligence is good for us to understand the current condition and future challenges of artificial intelligence. This article aims to study artificial intelligence in simple machine optimization and application of automation, find what issues humans are facing, and how simple machines fail to address them. And with the help of artificial intelligence, problems have been solved, and machines with artificial intelligence are getting better and better. Then discuss the advances and importance of artificial intelligence.

2. Basic theories and modern applications of simple machines

2.1. Basic concepts of simple machines

There are too many members belonging to simple machines, such as lever, pulley, axle, inclined plane, spiral, wedge, and so on. All of them have various concepts and applications. For example, a Lever is one of the simplest machines, a rigid bar that is pivoted at a fixed place called the fulcrum [2]. And there are lots of applications of levers, such as wheelbarrows and shovels [2]. For instance, an inclined plane is better than a ladder, because it's easier for us to push a cart up an inclined plane than lift the same thing straight up to the top with a ladder. The reason is that the applied force of the plane is less, but the work both people have done is the same [2]. Ancient Egyptians had built Egyptian pyramids by moving large blocks of stone on the plane to the top [2]. And it's also used widely in modern life.

2.2. Intelligent optimization of modern simple machinery

There are many examples that modern simple machines are intelligently optimized. One of them is the combination of a sensor and an adaptive adjustment system. An electro-hydraulic adaptive adjustment system was designed and installed by Liao et al. on the 4LZ-1.2 tracked self-propelled combine harvester [3]. It uses infrared photoelectric sensors to address the problem that the cutting height of sugarcane harvesters depends on operators' manual adjustment and failure of adaptive adjustment that changes in the ground height, though it still leaves some new problems for others to solve [3]. Another example is that Wen et al. raised a computer vision method based on camera images to control the height of cutting, which realized the combination of computer vision and mechanical motion control [3].

3. Application of AI in Simple machine automation

3.1. Intelligent leverage system

Artificial intelligence is now integrated with many simple machines, such as intelligent lever systems, intelligent pulleys, and lifting systems. We can find their principles from the following examples. In this study on the shortcomings of traditional garlic planters in stabilizing garlic seeds, the author designed a garlic seed orientation device based on image recognition technology. It utilizes an intelligent leverage system. It is called an intelligent lever-type garlic seed straightening mechanism. It is used for the garlic seed turning operation, automatically adjusting the direction of garlic seeds based on the recognized orientation of garlic bulbs, which can ensure the correct alignment rate during garlic sowing [4]. The intelligent lever-type garlic seed straightening mechanism mainly includes a frame, a garlic seed straightening channel, a lever-type garlic seed straightening device installation frame, a lever-type garlic seed straightening device, relays, and other parts [4]. The lever-type garlic seed straightening device is fixed under the garlic seed straightening channel by bolts through an installation bracket [4]. The garlic seed straightening channel is installed below the garlic seed channel, with its working surface parallel to the garlic seed channel [4]. The lever-type garlic seed straightening device consists of an electromagnet and an adjusting fork, which is composed of left and right parts and can swing around the connecting pin within a certain range [4]. The lever-type garlic seed straightening mechanism aligns the garlic seeds according to the direction of the garlic sprouts [4]. When the sprouts are located on the right side of the adjustment fork, the relay is closed, the electromagnetic iron is energized, and the electromagnetic iron core is lifted upward to drive the adjustment fork to rotate to the left [4]. The right adjustment fork is used to straighten the garlic seeds. When it is located on the left side of the adjustment fork, do the same as above. By adjusting the limit bolts on the left and right sides of the fork, the position of the fork can be adjusted [4]. When the garlic seeds in the straightening channel slide down and pass through the garlic seed straightening mechanism, the adjusting fork contacts the garlic seed bulb area [4].

Under the action of the adjusting fork, the garlic seeds rotate around the centre of gravity to complete the turning operation [4]. This is an example of the core technology of the intelligent leverage system.

3.2. Intelligent lifting system

In the following research about the control method of the intelligent lifting table under artificial intelligence is discussed. Its student constructs an intelligent lifting table space state model, because the intelligent lifting table drive has synchronization differences. Intelligent lifting tables are driven by dual permanent magnet brushed DC drive motors, generally [5]. The error is adopted as the input of the position PID controller, between the target position and the actual position [5]. The PID controller is adopted to adjust the PWM generator's duty cycle [5]. What's more, the PWM trigger signal adjusts driving voltage through the H-bridge circuit's PWM generator to drive the motor to rotate [5]. And if it is dual motors, error is adopted as the cross-coupling controller's input to atone for the dual motors' position deviation, reduce position error, and then realize the lifting table's precise control [5]. It is also a great combination of artificial intelligence and simple machines.

3.3. Agricultural applications

In the field of agriculture, artificial intelligence is also cleverly combined with agricultural production. Researchers use modelling to predict nutrient evolution in soil, to promote and determine correct fertilization management. The prediction of mineral nitrogen evolution is important, mainly depending on soil moisture, temperature, and OM; it can be achieved through empirical models that ignore potential processes, such as models supported by experimental data, and mechanism models based on theory that reproduce system behaviour by simulating potential processes [6]. These models are usually accurate within the conditions under which they are constructed, but their reliability decreases when these limitations are exceeded [6]. The mechanistic models, such as logistic and exponential models, that consider time, mineralization potential, zero-time mineralization nitrogen concentration, and mineralization rate constant have been successfully used to predict nitrogen availability in lowland soils [6]. Artificial intelligence helps farmers accurately predict the environment to improve crop production.

4. Real-life examples of AI in Simple machine optimization

4.1. Trash can

A trash can is a typical example of using the lever principle. With the increasing emphasis on low-carbon living, people's requirements for garbage classification are also becoming stricter. However, not everyone can achieve garbage classification every time, which makes it difficult for people to complete garbage classification on their own. However, smart trash cans equipped with intelligent image recognition technology can solve this problem. And when the garbage bag is full, the artificial intelligence recognition system and lever system will work together to help replace the garbage bag. This garbage bin combines leverage, artificial intelligence, and other technologies to identify the types of garbage, and adopts a timing belt connected door structure to quickly open and close the garbage inlet, reducing manual waiting time; In terms of picking up and placing garbage bags, this device adopts a lever structure, which converts the up and down movement of the foot pedal into the inclined side exit of the garbage bin, making it convenient for people to pick up and place garbage bags at any time [7]. The overall device is sealed when no garbage is placed, which can greatly prevent the emission of garbage odours and improve air quality [7]. The pedal lever structure of the device includes: garbage bin, housing, movable door panel, upper push rod, upper push rod bracket, connecting rod, lever, pedal, and lever bracket [7]. The main function of this structure is to provide stepping, which is converted into a tilted side exit of the garbage bin through a lever structure. The pin fixed on the bottom plate lever bracket is connected to the lever, and the lever is fastened to the foot pedal [7]. The other end of the lever is connected to the connecting rod pin and further connected to the upper push rod that can move up and down, restricted by the upper push rod bracket. After sorting the garbage, it falls into the corresponding type of garbage bin [7]. When the garbage in a bin is full, it is sensed by the infrared sensor on it and transmits a signal to the control system to further control the rotation of the motor [7]. At this time, the motor will drive the intermittent rotating mechanism to move, drive the turntable to move, push the turntable to rotate, and rotate the full garbage bin to the opening [7]. Then the signal light on the top shell lights up, prompting you to replace the garbage bag. When a person steps on the pedal, the lever structure will drive the push rod to push up, and the garbage bin will be tilted and pushed out, further pushing the movable opening baffle [7]. The garbage bin can then be removed from the device to replace the garbage bag. This is an excellent collaboration between artificial intelligence and simple machinery.

4.2. An intelligent rehabilitation robot

The next study is to investigate the effect of scalp acupuncture combined with an upper limb intelligent rehabilitation robot on shoulder joint function in stroke patients during the recovery period. The research sample consisted of 90 stroke patients in the recovery period from May to October 2020 [8]. They were randomly divided into a scalp acupoint group, a robot group, and a combination group using a random number table, with 30 patients in each group [8]. The study used the FMA-UE score and ADL score to assess upper limb function and daily living ability, and used sEMG analysis to understand changes in muscle activity [8]. The research results indicate that combination therapy can significantly improve patients' ADL scores and FMA-UE scores [8]. Compared with using scalp acupuncture or upper limb intelligent rehabilitation robots alone, combination therapy performs better in improving the range of motion of the affected shoulder joint. In addition, through analysis of sEMG, research has found that combination therapy can also improve patients' muscle control [8]. The research conclusion points out that the combination therapy of scalp acupuncture and upper limb intelligent rehabilitation robot is an effective rehabilitation method, which can help improve the quality of life and functional recovery of stroke patients in the recovery period.

4.3. In cranes

Cranes are common lifting equipment widely used in various fields. However, such devices face some problems, such as safety accidents caused by worker errors and poor working environments that endanger personnel's health. To solve these problems, intelligent cranes can be used. It uses traditional and intelligent path planning algorithms, such as A* Algorithms, Artificial Potential field Algorithm, ant colony algorithm, RRT algorithm, and so on, to make the crane effectively avoid obstacles to ensure finding the optimal path between the starting and target positions without collision [9]. In the practical process, researchers have come up with excellent path planning algorithms that can make cranes more intelligent [9]. However, traditional paths have shortcomings, and we need to innovate and improve them. With the integration of intelligent biomimetic algorithms and deep reinforcement learning algorithms, the field of unmanned cranes can develop and better cope with complex and dangerous environments.

4.4. In pipeline robots

Due to objective reasons such as large pipeline depth and dim lighting, manual inspection and pipeline maintenance are difficult in industrial, daily, and other scenarios of transportation pipelines. Compared with manual labour, pipeline robots can walk in different pipelines and can check and detect the status of the inner walls of pipelines in real time, with higher adaptability and safety. The main body of the intelligent pipeline cleaning robot in this design is a metal frame structure coated with a layer of waterproof material, which can be roughly divided into four parts: front cleaning unit, monitoring, transmission and intelligent unit, extended power cleaning unit, monitoring and power pushing unit, with a length, width and height of 1660 × 280 × 280mm [10]. When the robot starts working, it is in a non-extended state and not in a working state, and can pass through relatively narrow pipeline areas for monitoring and cleaning work [10]. Six-track wheels in the front and rear can achieve forward rotation and partial climbing functions [10]. The front cleaning plate can rotate to clean the pipeline, and the front drill bit can be used to pass through harsh environments [10]. When using cameras and underwater LiDAR to investigate the environment, it is equipped with two robotic arms, divided into mechanical claws and drill bits, for intelligent cleaning and repairing pipelines [10]. The rear of the robot is equipped with a thruster for crossing strong water flow areas. In environments with wide pipelines, robots can adapt to wider pipelines by changing their shape through extension motors on track pulleys. It conveniently, practically, and efficiently solves the disaster problems caused by pipeline rupture and dangerous gas and liquid pipeline leaks.

5. Conclusion

In summary, the monotonous functionality of traditional simple machinery is no longer sufficient to meet the increasingly diverse and complex demands of modern society. With the advancement of science and technology, researchers have demonstrated that the integration of artificial intelligence (AI) significantly enhances the performance, adaptability, and automation capabilities of simple mechanical systems. Through experimental studies and practical implementations, it has been shown that AI can optimize traditional mechanisms, resulting in the development of intelligent lever systems, automated lifting mechanisms, and smart solutions in agricultural production. These innovations not only improve operational efficiency but also expand the scope of application for simple machines, enabling them to respond dynamically to varying environmental and operational conditions. Real-world examples have already illustrated the substantial impact of AI-enhanced simple machinery across multiple sectors.

However, despite these promising developments, numerous challenges remain. A considerable number of mechanical devices continue to rely on manual operation and lack the intelligent optimization required for modern industrial applications. Integrating AI into simple mechanical systems often involves overcoming technical barriers such as sensor integration, real-time data processing, energy efficiency constraints, and cost-effectiveness. Furthermore, achieving seamless coordination between traditional mechanical components and AI-driven control algorithms demands interdisciplinary innovation and rigorous testing to ensure reliability and safety.

Future research should focus on expanding the application of artificial intelligence to a broader range of simple mechanical devices, particularly those operating in dynamic or harsh environments. Efforts should also be directed toward developing lightweight, low-cost AI modules specifically designed for mechanical systems with limited computational resources. Additionally, the combination of AI with emerging technologies such as the Internet of Things (IoT) and edge computing could further enhance the autonomy and responsiveness of simple machines. By addressing current challenges and promoting cross-disciplinary collaboration, the integration of AI into simple mechanical systems is poised to play an increasingly vital role in the advancement of intelligent automation and smart manufacturing in the future.

References

[1] Hiremath, Banadeshwar, and Anand Y Kenchakkanavar. “A Historical Perspective on Artificial Intelligence: Development, Challenges and Future Directions.” Journal of Advances in Library and Information Science, 17 Feb. 2025, vol. 14, no. 01, pp. 68–75,

[2] Pryce, Rob. “8.5 Simple Machines.” Openedmb.ca, Pressbooks, 6 Sept. 2022,

[3] Shi, Meiqi, et al. “Design of an Adaptive Height Control System for Sugarcane Harvester Header.” Proquest.com, 2025,

[4] Tian, Lin. "Design and experiment of garlic seed orientation device based on image recognition technology - China National Knowledge Infrastructure." Cnki.net, 2020,

[5] Guo, Haoran. “Intelligent Lifting Table Control Method under Artificial Intelligence.” Jpciams.com, 2024

[6] Toselli, Moreno, et al. “Smart Farming Tool for Monitoring Nutrients in Soil and Plants for Precise Fertilization.” Horticulturae, 1 Sept. 2023, vol. 9, no. 9, p. 1011

[7] Liu, Wenbin, et al." A Design of Intelligent Waste Classification Box - China National Knowledge Infrastructure." Cnki.net, 2021

[8] Zhu, Ronghua, et al. Clinical Study on the Effects of Cluster Needling at Scalp Points with Needle Retaining Combined with the Training of the Upper-Limb Intelligent Rehabilitation Robot on Shoulder Function in Stroke Patients during Convalescence. Cnki.net, 2024

[9] Yu, Guoxiang, and Shoubo Wang. Research on Lifting Path Planning Algorithms for Intelligent Cranes. Journal of Engineering Research and Reports, 11 June 2024.

[10] Peng, Fang, et al. Design of Intelligent Pipeline Detection and Cleaning Robot. Journal of Physics: Conference Series, 1 June 2024, vol. 2785, no. 1, p. 012025