ISSN 2959-6157

Application of Artificial Intelligence Technology in Milk Production

Shuxing Yi

Abstract:

Milk production is a crucial component of the agriculture industry, providing a vital source of nutrition for consumers worldwide. In recent years, artificial intelligence (AI) technology has revolutionized how milk is produced, monitored, and managed on dairy farms. By harnessing the power of AI, dairy farmers can optimize their operations, improve efficiency, and enhance the quality of their milk production. This paper explores the various ways AI technology is utilized in the dairy industry, specifically focusing on its application in milk production.

Keywords: Milk, AI, production, Agriculture

1. Introduction

Milk production is a crucial component of the agriculture industry, providing a vital source of nutrition for consumers worldwide. In recent years, artificial intelligence (AI) technology has revolutionized how milk is produced, monitored, and managed on dairy farms. By harnessing the power of AI, dairy farmers can optimize their operations, improve efficiency, and enhance the quality of their milk production. This paper explores the various ways AI technology is utilized in the dairy industry, specifically focusing on its application in milk production. AI is transforming how dairy farms operate from automated monitoring systems that ensure quality control to predictive analytics that optimize milking schedules. Additionally, AI-powered health assessment tools are helping farmers to proactively identify and address health issues in their herds, ultimately improving animal welfare and overall milk production. By embracing AI technology, dairy farmers can achieve higher yields, reduce waste, and ensure the sustainability of their operations.

2. Automated Monitoring: AI technology monitors milk production parameters, ensuring quality control and early detection of anomalies.

In the realm of milk production, the integration of Artificial Intelligence (AI) technology has ushered in a new era of efficiency and precision through automated monitoring systems. These AI-driven systems play a pivotal role in overseeing various critical parameters involved in milk production, ranging from the health of dairy animals to processing conditions. By continuously analyzing data from sensors and smart devices, AI ensures a real-time assessment of the production environment, contributing to the maintenance of optimal conditions for milk quality.

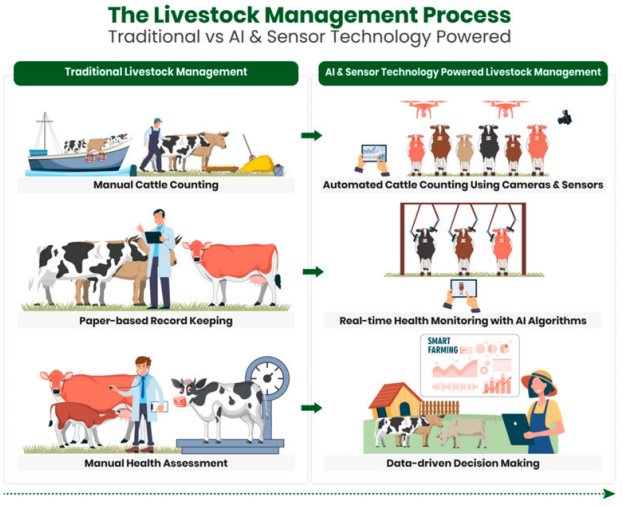

Fig. 1 The livestock management process: traditional vs. AI and sensor-technology-powered.[1]

One significant aspect of AI-powered monitoring in milk production is its ability to enforce stringent quality control measures. Through sophisticated algorithms, AI analyzes data streams to identify potential deviations from established quality standards. This proactive approach allows for immediate corrective actions, preventing the release of subpar milk products into the market. As a result, not only does AI technology enhance the quality of the produced milk, but it also safeguards the reputation of dairy producers by reducing the likelihood of product recalls or quality-related issues.

Furthermore, the automated monitoring facilitated by AI is a powerful tool for early anomaly detection. The research applied supervised ML techniques to improve dairy management. The data was recorded and collected

from smart devices that the cow wears. Those data can be integrated by ordering from the innovative wearable database and analyzed by using supervised machine learning algorithms like SVM, bagging and boosting techniques, K-nearest neighbor, and hybridization techniques, which classify the feature of the data with at most accuracy and can provide ultimate results to predict the nature of a herd of cows for the best production and the evaluation can be done by calculating precision, sensitive, recall, f-Measure and accuracy.[2] Unforeseen events, such as variations in milk composition or abnormalities in the production process, can be swiftly identified and addressed. Machine learning algorithms enable the system to learn and adapt over time, improving its ability to discern between normal fluctuations and potential issues. This preemptive capability not only safeguards the consistency and integrity of milk production but also minimizes the economic impact on dairy farms by mitigating losses associated with compromised batches. In essence, the application of AI technology in automated monitoring emerges as a cornerstone in pursuing excellence within the dynamic landscape of milk production.

3. Predictive Analytics: AI analyzes data to predict optimal milking times, enhancing efficiency and maximizing farm milk yield.

In the realm of milk production, the integration of Artificial Intelligence (AI) through predictive analytics has revolutionized traditional farming practices. By harnessing the power of advanced algorithms, AI systems can analyze various data points related to various factors influencing milk production. These factors may include environmental conditions, animal health indicators, and historical milking patterns. By comprehensively examining this diverse dataset, AI technology can predict optimal milking times with remarkable accuracy. This predictive capability empowers farmers with valuable insights, allowing them to streamline operations and strategically plan milking schedules for enhanced efficiency.

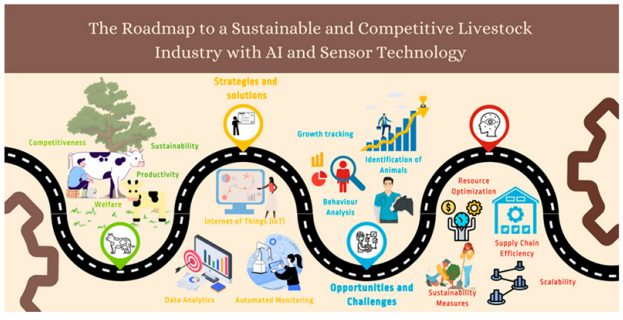

Figure 2. Impact of AI and sensor technology on livestock welfare and productivity.[1]

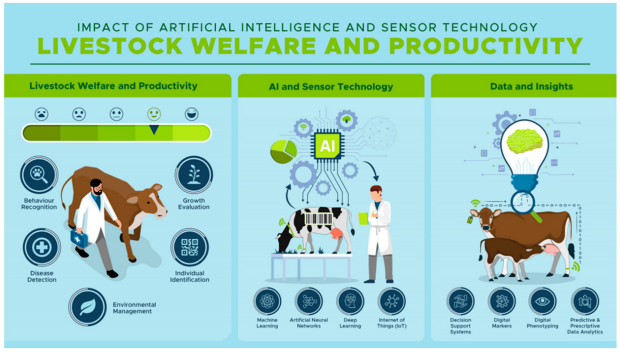

Figure 3. The roadmap to a sustainable and competitive livestock industry with AI and sensor technology.[1]

Moreover, using predictive analytics in milk production extends beyond identifying optimal milking times. AI algorithms can discern patterns and correlations within the data that might escape human observation. For instance, the system may uncover relationships between specific dietary regimes and variations in milk yield, enabling farmers to tailor nutrition plans for their dairy herd. Additionally, the technology can anticipate potential health issues in individual cows based on deviations from normal behavioral and physiological patterns. This proactive approach not only improves overall herd well-being but also contributes to preventing diseases that could negatively impact milk production.

From the research that used artificial neural networks (ANNs) in conjunction with genetic algorithms (GAs) to predict investment in cattle till age at first calving (AFC) and milk production based on body weight and AFC as input variables, the optimized results revealed that higher milk production is achievable at lower investment if the age at first calving is 768 days with a body weight of ~281 kg. The information generated by this investigation will aid in ensuring food security regarding higher milk production while making the dairy business more sustainable and profitable for the farmers.[3]

Incorporating AI-driven predictive analytics is a game-changer for the dairy industry, as it empowers farmers to make informed decisions to maximize milk yield. By leveraging historical data, current environmental conditions, and real-time health indicators, these systems give farmers a holistic view of their operations. This foresight enables proactive management strategies, ultimately leading to increased productivity and profitability in the milk production process. As technology advances, the marriage of AI and predictive analytics holds immense promise for shaping the future of sustainable and efficient dairy farming practices.

4. Health Assessment: AI-powered systems assess the health of dairy cows, identifying potential issues and ensuring overall herd well-being.

AI-powered systems have revolutionized the health assessment of dairy cows by offering real-time monitoring and analysis. These systems utilize various sensors, including wearable devices and cameras, to gather data on the cows' behavior, movement, and physiological parameters. By continuously collecting and analyzing this data, AI algorithms can detect subtle changes indicative of health issues, such as changes in feeding patterns, lameness, or abnormal body temperature. This proactive approach enables early intervention, preventing potential diseases or injuries and minimizing the impact on milk production.

Moreover, AI-based health assessment systems can provide personalized care for each cow within the herd. By integrating individual cow data with historical records and breed-specific information, these systems can tailor recommendations and interventions to address specific needs and optimize health outcomes. For example, AI algorithms can adjust feeding schedules, monitor medication adherence, or recommend veterinary consultations based on the unique health profile of each cow. This personalized approach enhances the efficiency of health management practices and contributes to the overall well-being of the herd.

Furthermore, AI-powered health assessment systems contribute to sustainable milk production practices by promoting preventive healthcare and reducing the reliance on antibiotics and other medical interventions. By identifying health issues early, farmers can implement targeted interventions, such as dietary adjustments or environmental improvements, to mitigate risks and enhance the resilience of the herd. This proactive approach not only improves animal welfare but also minimizes resource use and lowers milk production's environmental footprint. Thus, the application of AI technology in health assessment aligns with the goals of sustainable agriculture and ensures the long-term viability of dairy farming practices.

5. Smart Resource Management: AI optimizes feed and resource allocation, reducing waste and improving sustainability in milk production operations.

In modern milk production, the effective management of resources is paramount to ensure economic efficiency and environmental sustainability. Artificial Intelligence (AI) technologies offer promising solutions by optimizing feed and resource allocation processes. Using AI algorithms, farms can analyze vast amounts of data, including environmental conditions, herd health metrics, and feed composition, to tailor feeding regimens for individual animals. This targeted approach minimizes feed waste while ensuring optimal nutrition, ultimately leading to improved milk production efficiency.

Moreover, AI systems can dynamically adjust resource allocation based on real-time data inputs, such as weather patterns, milk yield, and feed availability. By continuously monitoring and analyzing these variables, AI algorithms can adapt feeding schedules and resource distribution to maximize milk output while minimizing waste. Additionally, AI-powered predictive analytics can forecast future resource needs and identify potential bottlenecks in the production process, allowing farms to proactively address issues and optimize resource utilization.

From the research for dynamic optimization of the milk-run system (MRS) managed with an IT-based Kanban (ITK), through exploring how artificial intelligence may allow MRS to choose the most efficient path and measure the impact on the main production parameters, the study explores the Kanban signals activating an ant colony optimization algorithm that finds the best path from supermarket to the lines. Then, the genetic algorithm solves an objective function to find the optimal delivery times according to the paths found. The optimal path is dynamically found for each MRS supply cycle. Significant improvements in production parameters and overall system performance have been appraised in the empirical results. The lead time and material handling time show a strong decrease to 39% and 48%, respectively, while work in the process decreases by 22% for all assembly lines. Workstation starvation decreased by 43%, and machine saturation increased by 37%.[4]

Also, The Edge-AI-based architecture allows the implementation of in-situ milk adulteration detection techniques in dairy processing, hence providing real-time monitoring of milk quality. The research uses an edge device (Jetson Nano) to process the Fourier Transformed Infrared (FTIR) based data to classify contaminants in the milk dataset. A Convolutional Neural Network (CNN) model addresses the classification problem. The edge device achieved 94.87% accuracy in classifying the adulterants present in the milk dataset.[5]

Furthermore, implementing AI technology in resource management contributes to the broader goal of sustainability in milk production. By minimizing feed waste and optimizing resource allocation, farms can reduce their environmental footprint by lowering greenhouse gas emissions and conserving natural resources such as water and land. Additionally, the improved efficiency resulting from AI-driven resource management translates to economic

benefits for farmers, enhancing milk production operations' overall viability and resilience in an increasingly competitive market landscape. Overall, the integration of AI technology in resource management represents a significant advancement in modernizing and optimizing milk production practices toward a more sustainable and efficient future.

6. Conclusion

In conclusion, integrating artificial intelligence technology holds tremendous promise for revolutionizing milk production practices. Through automated monitoring, predictive analytics, health assessment, and smart resource management, AI systems offer unparalleled efficiency, quality control, and sustainability in dairy farming. By harnessing the power of AI, farmers can optimize milk production processes, ensure animal welfare, and maximize yields. As technology advances, the dairy industry must embrace these innovations to meet the growing demands for high-quality milk while promoting environmental stewardship and animal welfare.

References

[1] Suresh Neethirajan. "Artificial Intelligence and Sensor Technologies in Dairy Livestock Export: Charting a Digital Transformation." *Sensors*, vol. 23, no. 16, 9 Aug. 2023, pp. 7045–7045, doi.org/10.3390%2Fs23167045, https://doi.org/10.3390/s23167045.

[2] Marjona Shavkat qizi Sobirova. *Can Machine Learning Algorithms Improve Dairy Management?* 1 Jan. 2023, pp. 379–390, https://doi.org/10.1007.

[3] Bhardwaj, Sonam, et al. "Determining Point of Economic Cattle Milk Production through Machine Learning and Evolutionary Algorithm for Enhancing Food Security." *Journal of Food Quality*, vol. 2023, 2 Feb. 2023, pp. 1–9, https://doi.org/10.1155/2023/7568139. Accessed 13 Dec. 2023.

[4] Marialuisa, Menanno, et al. "Optimizing Milk-Run System and IT-Based Kanban with Artificial Intelligence: An Empirical Study on Multi-Lines Assembly Shop Floor." *Production & Manufacturing Research*, vol. 11, no. 1, 23 Feb. 2023, https://doi.org/10.1080/21693277.2023.2179123. Accessed 27 Feb. 2023.

[5] Rahul Umesh Mhapsekar, et al. *Edge-AI Implementation for Milk Adulteration Detection*. 18 Dec. 2022, https://doi.org/10.1109/gcaiot57150.2022.10019173. Accessed 15 Mar. 2024.