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Professional paper

INTRODUCTION OF THE USE OF ARTIFICIAL INTELLIGENCE IN THE PRODUCTION OF CHICKEN MEAT AS A NECESSARY NEED OF THE INDUSTRY SURROUNDING THE SMART CITY

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Abstract

The use of artificial intelligence (AI) in the production industry can be extremely useful in several ways, starting from primary production itself, through fattening broilers, and at the end of the meat production process itself, which includes slaughtering, cooling, cut ups, measuring and packaging, transportation. Artificial intelligence can contribute the most through optimization of the production process, control of the production process, quality control, predictive maintenance, robotization, improvement of supply chain management as well as product personalization. When it comes to the complete cycle of chicken meat production, nowadays complete robotic solutions are available for each of the mentioned processes. Man only has the role of operator in such solutions. I am of the opinion that with the help of AI the human as an operator can be replaced and, in that way, get a far more efficient system and use a fully automated production process. In short, artificial intelligence has the potential to improve various aspects of operations in the meat industry, from production and product quality to supply chain management and customer satisfaction.

Keywords: *Optimization of production processes, Robotization, Quality control, Predictive maintenance, Improvement of supply chain management, Personalized products*

A smart city is an urban development concept that uses information and communication technologies (ICT) and the Internet of Things (IoT) to improve citizens' quality of life, resource efficiency, sustainability and interaction with city infrastructure systems.

The main goal of smart cities is to use digital technologies to improve various aspects of city infrastructure and services, including.

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Transportation

Smart cities use technologies such as smart traffic lights, traffic and public transportation sensors, and smart travel planning applications to improve transportation efficiency, reduce congestion, and reduce emissions.

Energy efficiency

By implementing smart grids for electricity distribution, systems for managing energy consumption in buildings and using renewable energy sources, smart cities aim to reduce energy consumption and increase sustainability.

Resource use

Smart cities use technologies to monitor and manage water consumption, waste management and recycling to reduce the amount of waste they produce and use natural resources more efficiently.

Management of public services

The use of digital platforms and applications allows citizens easier access to public services such as health care, education, waste management and security.

Smart buildings and infrastructure

The integration of sensors, devices and control systems enables smart management of buildings, lighting, water systems and other infrastructure to increase the efficiency and comfort of citizens' lives.

Smart cities use data and analytics to make informed decisions and improve the experience of their citizens. This concept aims to create sustainable, innovative and inclusive urban environments that can adapt to the needs of their inhabitants and future challenges.

AUTOMATION OF BROILER FARMING

Broiler breeding is a complex process that requires precise management in order to achieve high efficiency and product quality. Artificial intelligence is increasingly being used in this sector to automate various processes and improve production performance.

Nutrition management

One of the key elements of successful broiler breeding is optimal nutrition. Artificial intelligence systems analyze large amounts of data on nutrition, broiler quality and



environment to generate customized diets for each turn. This enables more efficient use of feed and improves the growth and health of broilers, as well as uniformity in the average weight of broilers, more precisely, the occurrence of stratification as little as possible.

Broiler health monitoring

The use of sensors and cameras in combination with artificial intelligence algorithms enables constant monitoring of broiler health. Systems can detect signs of disease, stress or other problems in broilers based on their behavior, body temperature or other physiological parameters. Such early detection enables quick intervention by veterinary experts and prevents the spread of disease among the flock.

Optimization of environment management

Artificial intelligence is used to precisely manage environmental conditions in broiler breeding facilities. This includes controlling temperature, humidity, lighting and ventilation. Artificial intelligence algorithms analyze data on external conditions, broiler condition and system energy efficiency to automatically adjust environmental parameters and ensure optimal conditions for broiler growth and well-being.

Advantages

Increased productivity. Automation of broiler farming with the help of artificial intelligence leads to increased productivity and reduced production costs.

Better quality control. Artificial intelligence enables precise monitoring and control of various parameters that affect the quality of broiler meat.

Reducing the risk of disease. Bird health monitoring enables early disease detection and rapid response, which reduces the risk of epidemics and improves flock welfare.

Challenges

Technical challenges. Developing reliable artificial intelligence systems for analyzing and interpreting complex real-world data is a technical challenge.

Ethics and Morality. The use of artificial intelligence in animal farming raises questions of ethics and morality, particularly in relation to animal welfare and consumer rights.

High implementation costs. Implementing AI systems can require significant investments in technology, staff training, and farm infrastructure changes.

Selection of genetic lines. Using artificial intelligence to analyze genetic data can help breeders select genetic lines that have the best characteristics in terms of rapid growth, feed-



to-meat conversion and disease resistance. This can lead to the breeding of broilers with improved genetic characteristics and better meat quality.

ROBOTIZATION AND AUTOMATION OF THE PRODUCTION PROCESS

Artificial intelligence can be used to manage automated slaughter systems. Algorithms can control slaughtering and meat processing machines to ensure precise and efficient operations, minimizing errors and meat damage.

Artificial intelligence can manage the following production lines.

- slaughter line
- line of evisceration
- cooling line
- cutting and boning line
- packaging line

Slaughter line

By constantly adjusting the equipment such as the stunner, the killer machine, the scalding, the plucker, better meat quality can be achieved due to faster and more efficient processing. Bleeding time, as well as steam/water temperatures during scalding are one of the main elements when it comes to product shelf life.

Evisceration line

Depending on the size of the poultry carcasses, each of the machines on the evisceration line can be adjusted so that processing is as efficient as possible. The quality and cleanliness of the inside of poultry carcasses is also one of the key factors when it comes to the length of shelf life of chicken meat.

Cooling line

By adjusting the operation of the evaporator depending on the size of the poultry carcasses and external ambient conditions, higher energy efficiency can be achieved. By using thermal cameras, the fan on the evaporators can be accelerated or slowed down or even turned off depending on the temperature of the poultry carcasses that are in the cooling process, for the sake of greater energy efficiency.

Cutting and deboning line



With scanner cameras, the knives on the cutting line and the deboning line can be adjusted to the anatomy of each poultry carcass individually. In this way, a higher quality product is obtained, and a greater yield is also achieved.

Packaging line

1. Automatic Sorting and Packaging. AI can operate automatic sorting and packaging systems for meat based on various criteria such as size, weight, shape and quality. Machine vision algorithms analyze the visual characteristics of the meat and automatically sort it into the appropriate categories, increasing the efficiency of the packaging process.
2. Optimization of packing layout. AI can use optimization algorithms to determine the optimal packing layout in boxes, containers or transport pallets. This includes maximizing packing capacity, minimizing waste of space and ensuring even weight distribution to prevent damage during transport.
3. Monitoring the quality of packaging. AI can use sensors and cameras to monitor the quality of meat packaging. For example, algorithms can analyze the integrity of packaging, the presence of damage or irregularities in packaging, as well as the correctness of product information labels. This enables automatic detection and correction of packaging problems before products reach the market.
4. Inventory monitoring and management. AI can analyze data on demand, inventory and consumption trends to generate accurate forecasts and recommendations for inventory management. Based on these analyses, manufacturers can optimize inventory levels, reduce storage costs, and reduce the risk of shortages or overstocks.
5. Determining the right packages for each customer. AI can use personalized algorithms to determine the right packages of meat for each customer based on their preferences, requirements and purchase history. This allows manufacturers to provide a personalized experience to customers and increase shopping satisfaction.

QUALITY CONTROL

Visual inspection of meat

AI algorithms can analyze visual characteristics of meat, such as color, texture, presence of damage or irregularities, to automatically identify products that do not meet quality standards. Machine learning allows these algorithms to be trained on a large number of meat samples, improving accuracy in identifying undesirable characteristics.



Sensor quality monitoring

The use of sensors to measure various meat characteristics, such as temperature, pH value, moisture content or the presence of microorganisms, enables continuous monitoring of meat quality throughout the entire production and distribution process. Artificial intelligence can then be used to analyze this data and identify potential problems or deviations from standards.

Automatic identification of defects

Artificial intelligence algorithms can analyze data obtained during the meat production process to identify the causes of defects or irregularities. For example, the processes that lead to the appearance of bacteria or the oxidation of meat can be identified, thus enabling preventive measures to be taken to prevent further problems.

Determining the categorization of meat

Artificial intelligence can be used to automatically determine the categorization of meat based on various parameters, such as parts of the carcass, the presence of gravy, insufficient quality processing/cutting, etc. This facilitates the sorting of meat and ensures that the products are correctly categorized before they reach the market.

Regulatory compliance monitoring

Artificial intelligence can be used to monitor compliance with regulations and standards related to meat quality. Algorithms can analyze data on the composition, safety and nutritional value of meat to ensure that products meet all legal requirements and quality standards. Also, using AI, traceability from the farm to the final product can be followed.

EQUIPMENT MAINTENANCE

When it comes to the use of artificial intelligence for equipment maintenance in a poultry slaughterhouse, it is crucial to highlight the following.

Predictive maintenance

Artificial intelligence can analyze equipment performance data to predict potential failures before they happen. This enables preventive maintenance that reduces downtime and repair costs.

Optimizing maintenance schedules



Artificial intelligence algorithms can analyze data on maintenance history and equipment performance to generate optimal maintenance schedules. This ensures that maintenance is carried out at the right time, minimizing production interruptions.

Automation of fault diagnosis

Artificial intelligence can analyze sensor data and visual information to identify potential problems or irregularities in the operation of equipment. This allows for quick fault diagnosis and more efficient troubleshooting.

Suggestions for optimizing equipment performance

Based on data analysis, artificial intelligence can generate suggestions for improving equipment performance or optimizing work processes. This enables continuous improvement of efficiency and productivity.

Integration with monitoring and management systems

Artificial intelligence can be integrated with equipment monitoring and management systems to automate maintenance processes and enable real-time monitoring of equipment conditions.

Using artificial intelligence to maintain equipment in a poultry slaughterhouse can result in more efficient, reliable and economical operations, which contributes to the improvement of the overall business.

SUPPLY CHAIN IMPROVEMENT

Artificial intelligence (AI) plays an increasingly important role in the supply chain, as it enables process automation, optimization of operations and informed decision-making. Here are some ways that AI can be used in the supply chain.

Predictive planning and inventory management

AI can analyze large amounts of data on demand, sales trends, seasonal variations and other factors to predict future demand and generate optimal inventory management plans. This enables businesses to optimize inventory levels, reduce storage costs and reduce the risk of shortages or overstocks.

Route optimization

AI can use optimization algorithms to determine the most efficient routes for transporting goods. Based on factors such as distance, time, fuel costs, and traffic conditions, AI can generate optimal routes that minimize transportation costs and delivery times.



Quality Controls in the Supply Chain

AI can use sensors, cameras and data analysis algorithms to monitor product quality throughout the supply chain. For example, AI can detect damage to products, monitor compliance with quality standards, and identify potential problems that may affect product quality.

Automation of storage and handling of goods

AI can manage automated storage and handling of goods systems to increase efficiency and reduce labor costs. For example, AI can operate robotic vehicles for warehousing and order preparation, thereby speeding up the process of preparing and delivering goods.

Supply chain risk analysis

AI can use advanced data analysis techniques to identify potential risks and recognize points of weakness in the supply chain. Based on this analysis, businesses can take proactive measures to reduce the risk of supply chain disruptions and ensure business continuity.

In short, artificial intelligence has wide applications in the supply chain, enabling businesses to optimize operations, reduce costs and improve service quality. This trend is likely to continue as AI technology continues to develop and be applied in increasingly complex applications

CONCLUSION

Improving efficiency

The application of artificial intelligence in a poultry slaughterhouse can significantly improve process efficiency, reduce costs and increase productivity. Automating certain processes, such as sorting, packaging and inspection, can speed up production and reduce the need for human labor.

Quality improvement

Artificial intelligence enables more precise inspection and quality control of poultry meat. Camera vision systems and data analysis can identify defects, damage or disease in poultry, ensuring that only high-quality meat enters the supply chain.

Increasing safety

Automating and monitoring the poultry slaughtering process with the help of artificial intelligence can improve worker safety and reduce the risk of workplace injuries or accidents.



Technologies such as poultry handling robots can reduce the need for physical contact with animals, thereby reducing the risk of injury.

Sustainability

Artificial intelligence can contribute to the sustainability of the poultry slaughtering process through more efficient use of resources, reduction of waste and better management of energy consumption. For example, optimizing meat cooling and storage processes can reduce energy and resource consumption.

Innovation

The application of artificial intelligence in the poultry slaughterhouse opens the door to innovation and progress in the industry. Continuous research and development of new technologies can lead to further improvements in the efficiency, quality and sustainability of the poultry slaughtering process.

In conclusion, artificial intelligence has significant potential to improve all aspects of the poultry slaughtering process, from efficiency and quality to safety and sustainability. Its comprehensive contribution to the poultry slaughter industry can lead to improved overall operational excellence and market competitiveness.

REFERENCES

- [1] Liao, Y., Song, L., Li, B., Chen, L., Huang, J., Chen, X. , ... & Shen, J. (2019). A real-time monitoring and control system for broiler breeding based on IoT and big data. *Computers and Electronics in Agriculture*, 161, 270-278.
- [2] Zhang, J., Zhao, X., & Han, D. (2019). Research on intelligent environment monitoring system based on IoT in broiler houses. *IOP Conference Series. Earth and Environmental Science*, 316(1), 012030.
- [3] Lea, PJ, Aghdam, EH, Pocock, A., & Hawkes, ER (2020). Machine learning-based poultry inspection system. *Computers and Electronics in Agriculture*, 178, 105750.
- [4] Oliveira, MM, Barbedo, JGA, & Pereira, GM (2019). Automatic grading of poultry meat quality using computer vision. *Computers and Electronics in Agriculture*, 162, 602-611.
- [5] Liu, Y., Zhou, Z., Ye, F., Zhu, J., & Sun, DW (2020). Machine vision technology in the quality inspection of poultry and poultry products. A review. *Trends in Food Science & Technology*, 95, 64-78.
- [6] Kaur, A., & Gupta, P. (2020). Artificial intelligence in the food processing industry. Challenges and opportunities. In *Artificial Intelligence in Agriculture* (pp. 25-44). Springer, Singapore.
- [7] Gómez-Sanchís, J., Catalá, A., & García-Breijo, E. (2020). Machine Learning Techniques for Quality Assessment in the Meat Industry. A Review. *Animals*, 10(11), 1991.



- [8] Wang, P., Zhang, L., He, X., Chen, X., & Wang, S. (2017). An Application of Artificial Intelligence in Food Processing. In 2017 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM) (pp. 1445-1449). IEEE.
- [9] Li, S., & Cheng, J. (2019). Deep Learning Based Smart Sorting System for Meat Packaging. In 2019 IEEE 4th International Conference on Advanced Robotics and Mechatronics (ICARM) (pp. 70-75). IEEE.
- [10] Li, X., Chen, Y., Cheng, TCE, & Zhang, M. (2018). Predictive maintenance of equipment systems using artificial intelligence. A review and new perspectives. IEEE Transactions on Systems, Man, and Cybernetics. Systems, 49(2), 243-257.
- [11] Ahuja, IS, & Khamba, JS (2020). Artificial intelligence and machine learning techniques in equipment maintenance. A systematic literature review. Journal of Manufacturing Systems, 54, 1-23.
- [12] Chopra, S., & Meindl, P. (2007). Supply chain management. strategy, planning, and operation. Prentice Hall.