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Artificial Intelligence in Food Industry: Application and its Uses

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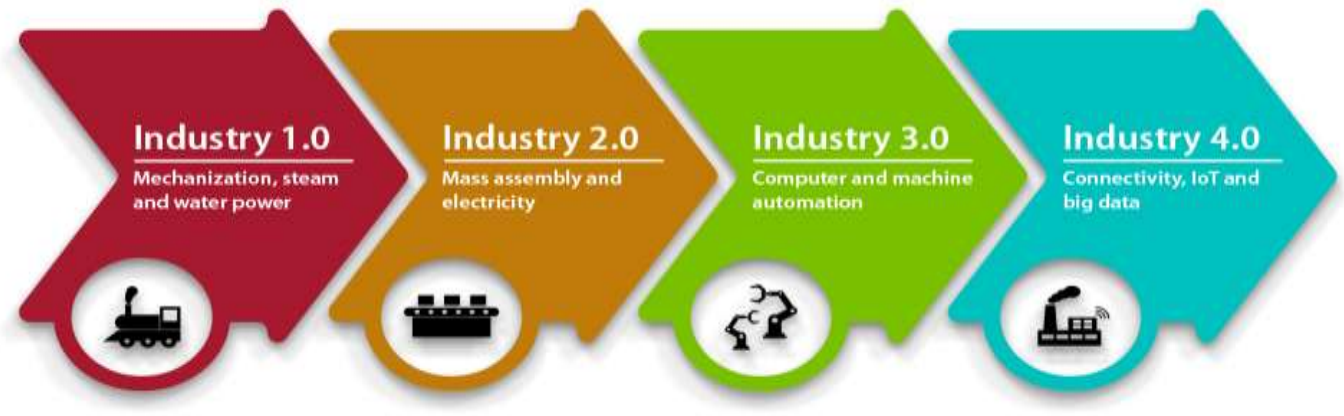
SUMMARY

Food is a fundamental need for humans, making it crucial to reduce waste, improve supply chains enhance logistics, delivery, and safety. Artificial intelligence (AI) and machine learning play a significant role in achieving these objectives. The advancement of sophisticated computing networks supports modern industrial and logistical systems, generating vast amounts of data from sensors, machines, systems, intelligent devices, and people. These advancements have introduced a new era known as Industry 4.0 or the Smart Factory, highlighting the importance of AI. This article explores the applications of machine learning and AI in the food industry and manufacturing, focusing on areas such as supply chain optimization, crop selection, logistics, food delivery, and predictive maintenance for food processing machinery.

INTRODUCTION

Artificial intelligence (AI) is defined as a field in computer science that imitates human thinking processes, learning ability, and storage of knowledge (Krittanawong et al., 2017 ; Hamet and Tremblay 2017). AI has a huge application in food industry. This technology has helped food industry to deal with the problems of human error. Food processing industry is the fifth largest sector of the country which contributes in GDP (Zia Mohammad, 2016). Due to the rising demand for food in line with the world's population, artificial intelligence (AI) has become the latest technology in the food industry over the past few decades. The ability of the said intelligent systems to perform a variety of tasks, such as determining food quality, controlling tools, classifying food, and making predictions, has increased the demand for them in the food industry. The integration of this system with other devices like the electronic tongue, electronic nose, computer vision system, and near infrared spectroscopy (NIR) is also emphasized, all of which will benefit industry players and consumers (Nidhi et al., 2021). Advanced cognitive computing and deep learning approaches have been developed for automated visual inspection, failure detection and maintenance applications in fabrications systems. Strengthening learning approaches are actively used to material handling systems and production schedules. Industries seeking to turn real-time data into practical choices are finding ways to blend AI methodologies with conventional operational research approaches, Internet of Things (IoT) concepts and technology and cyber-physical systems (Manne and Kantheti 2021).

Fig. 1 summarizes the evolution of the industrial revolution (Kulova 2022).



Industry 1.0 is the first industrial revolution in human history. It developed in the second half of the 18th century. The mechanization of manual labor, the power of wind, water is connected. The steam engine was put into operation in production and transport.

Industry 2.0 developed at the end of the 19th century. It is associated with the introduction of electricity and the introduction of mass production.

Industry 3.0 is characterized by the application of electronics, electronic technologies and computers, in which the automation of production processes is achieved.

The opening of local economies on a global scale is a stage known as Industry 3.5. It is characterized by relocation of production, i.e. export of production from developed to less developed economies

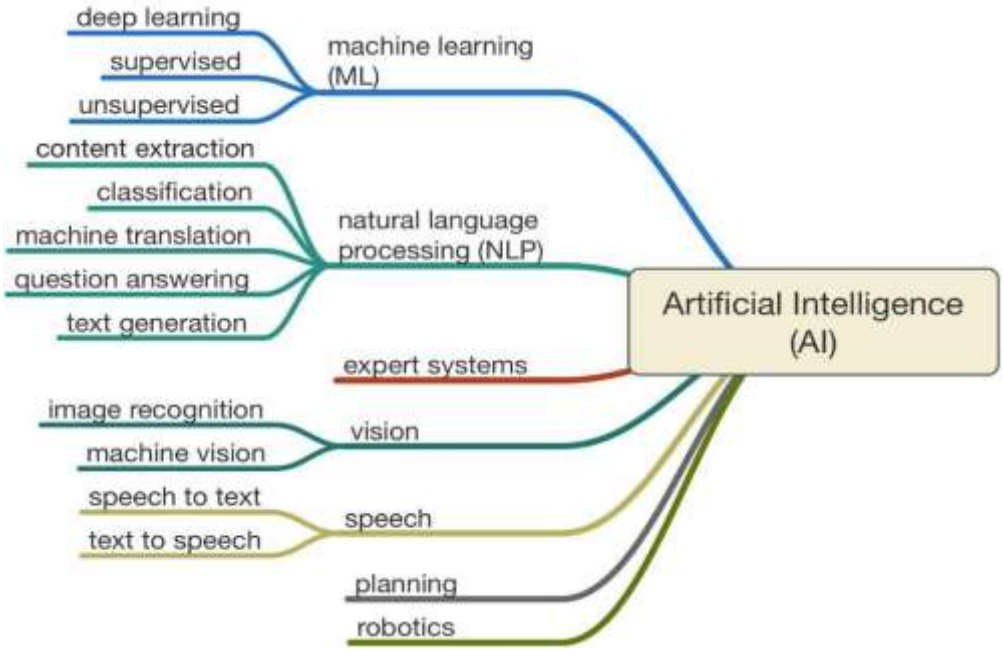
With the introduction of Internet technologies in production, the fourth industrial revolution in human history is formed - Industry 4.0. New technologies allow the use of various cloud solutions for processing big data, building smart factories, virtual copies of the real world, collaboration between people in real time via the Internet, making decentralized decisions to achieve organizational excellence.

The technological toolkit of Industry 4.0 is summarized in fig. 2.(Saleh 2019)

Despite the fact that Industry 4.0 is at an initial stage of its development and its main achievements can be expected in the current decade, the image of the new industrial revolution - Industry 5.0, which includes the penetration of artificial intelligence into the everyday life of a person, can already be outlined.

Industry 5.0 is associated with the entry of bionics and biotechnology into production processes. This allows the application of biological sensors for the organization and control of production.

Different fields of artificial intelligence:



The most important among them are as follows:

Machine Learning (ML)

It is the scientific study of algorithms and statistical models that enable computer systems to perform specific tasks without explicit instructions, relying instead on patterns and inference (Bishop 2016). For instance, to identify a simple object like an apple or an orange, the system doesn't depend on detailed coding. Instead, it learns by being shown numerous pictures of the objects, much like how a child learns to recognize them, allowing the machine to determine the steps needed for identification.

Natural Language Processing (NLP)

Natural Language Processing (NLP) is generally understood as the automatic handling of natural language, including both speech and text, by software. This subfield of computer science focuses on how computers can interact with human languages, specifically on programming them to process and analyze large volumes of natural language data (Goldberg 2016).

Vision

It is a scientific discipline that allows machines to perceive their environment. Machine vision involves capturing and analyzing visual information through a camera, analog-to-digital conversion, and digital signal processing. Its goal is to automate tasks that the human visual system is capable of performing (Milan et al., 2008).

Robotics

It is a field of engineering and science focused on the design, construction, operation, and application of robots, along with the computer systems that control them, provide sensory feedback, and process information. These technologies are used to create machines that can replace humans and mimic human actions (Tondu 2012; Wettels et al., 2008). Robots are frequently employed to carry out tasks that are challenging for humans or that require consistent performance.

Applications of artificial intelligence in food industry

Sorting Fresh Produce

One of the biggest challenges faced by food processing plants relates to the irregular availability of feedstock. Food processing plants depend on manual sorting to sift and sort vegetables, leading to loss of efficiency and increased costs (Hammerkopf 2019).

By using Artificial Intelligence, food processing companies can achieve significant automation for food cataloguing, using a combination of cameras, lasers and machine learning to enable food sorting with enhanced efficiency. For instance, by deploying Artificial Intelligence involving sensor-based optical sorting solutions, the tardy time-consuming processes for sorting fresh produce can be removed, leading to higher yield with better quality and lesser wastage (Shobhit 2019). AI is used as a means to better calibrate machines in order to manage several product sizes and reduce waste and costs (Sebastin 2018).

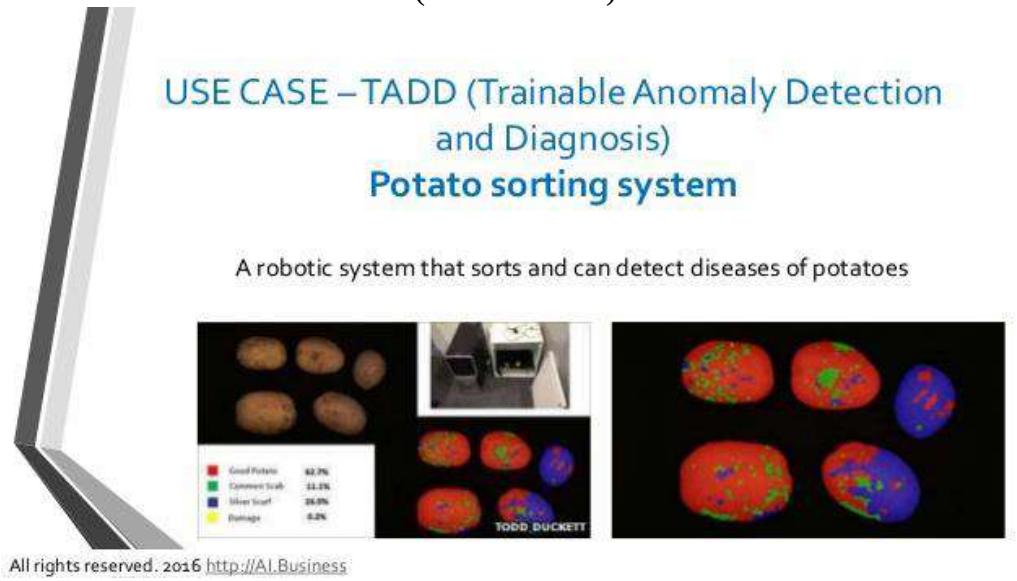


Figure 4: Potato sorting system (Tan 2019).

Efficient Supply Chain Management

Supply chain management is top priority for all food companies with the increasing need for transparency. The food industry is using AI to improve supply chains through Food safety monitoring and testing product at every step of the supply chain to ensure compliance to industry and consumer specifications. More accurate forecasting to manage pricing and inventory (Shobhit 2019). AI-based image recognition technologies enable better and more efficient procurement of produce. AI also helps in efficient and transparent tracking of produce from farm to the consumer, leading to increased confidence amongst consumers (Hammerkopf 2019).

Food Safety Compliance

AI enabled cameras are used to ensure safety compliance amongst food workers in food facility. This employs facial-recognition and object-recognition software to determine whether workers are complying with good personal hygiene as required by food safety law. If violation is found, it extracts the screen images for review which can be rectified in the real time (Kurilyak 2019). The accuracy of this technology is more than 96% (Shobhit 2019).

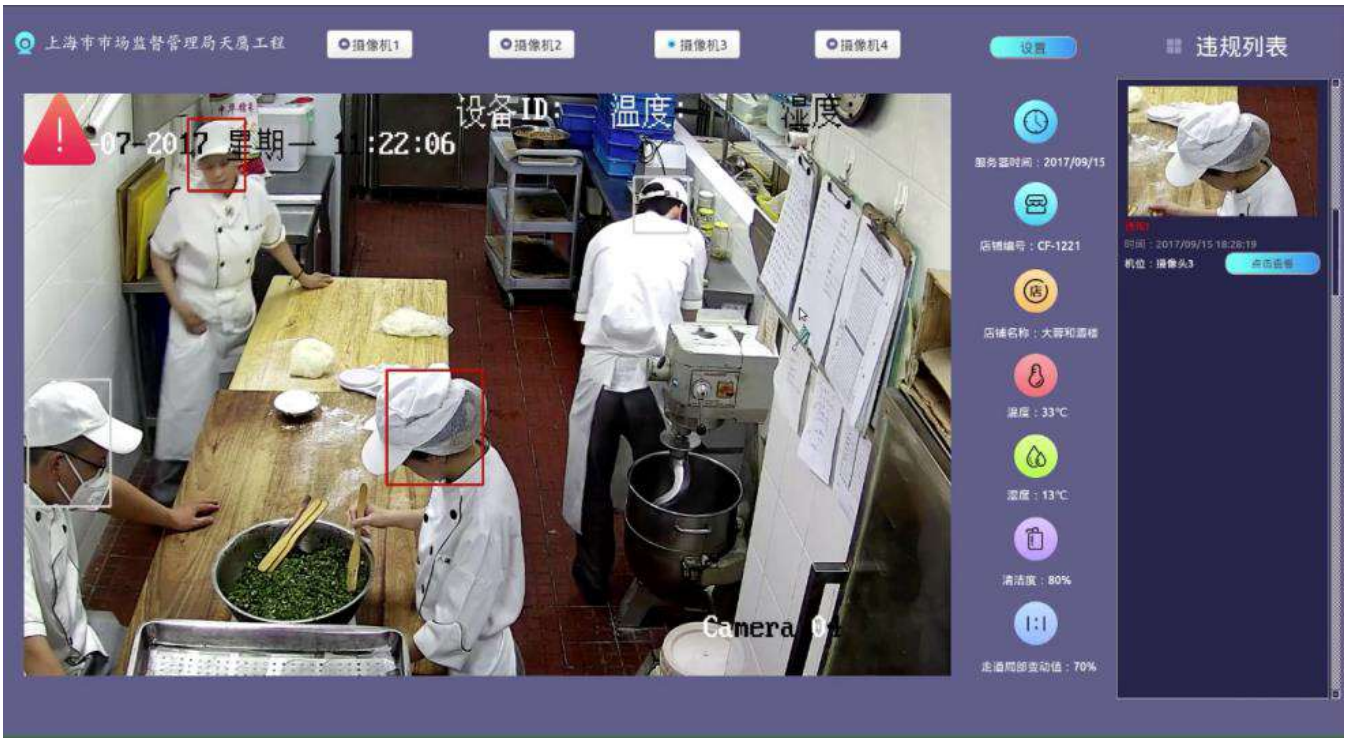


Figure 5 AI enabled camera in a food facility (Walker 2019)

Developing New Products

AI technology uses machine learning and predictive algorithms to model consumer flavour preferences and predict how well they will respond to new tastes. The data can be segmented into demographic groups to help companies develop new products that match the preferences of their target audience (Shobhit 2019). Across numerous restaurants and other locations, Coca-Cola has installed self-service soft drink fountains which allow individuals to customize their own drinks. Customers can use these self-service machines to theoretically create hundreds of different drinks by adding different flavors to their base beverages (Walker 2019).

Artificial intelligence in restaurant

The use of AI robots has become well known worldwide and the implementation of this technology has spread from industrial manufac- turing to service industry. Varieties of different types of robots have replaced. Humans are easily replaced by robots in guiding, reception, and delivery services. The restaurant's robots can be used in many as- pects, starting from washing, cutting of vegetables, sorting of the dishes, even for serving and cleaning of dishes (Yuqi and Young-Hwan, 2020). Robot can function for recycling of the garbage collected from the plate and also gives self-delivery. Once the customer completes eating, they just press the bell placed beside the dining table for calling the robot. At the starting waiters come to the table for the cleaning function, once robot reaches its destination table, the customer takes the charge of placing the plates, containers, tableware etc. Then the customer needs to select "return to origin" (Yuqi and Young- Hwan, 2020).

CONCLUSION

Conclusively, artificial intelligence (AI) has proved essential in the food sector for a multitude of purposes including modeling, prediction, control tools, food drying, sensory assessment, quality control, and troubleshooting sophisticated food processing issues. Aside from that, AI's capacity to estimate sales and permit yield increases allows it to improve business strategy. Due to its ease of use, precision, and cost-effectiveness in the food sector, artificial intelligence is well known. In the sphere of agriculture and the food business, this paper describes the application of technology from the fourth industrial revolution, such as computer vision and artificial intelligence. With regard to agricultural applications like food processing, the current review in particular offers a thorough grasp of computer vision and intelligence approaches.

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