Recent Scope for AI in the Food Production Industry Leading to the Fourth Industrial Revolution

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Abstract

In today's situation, Artificial intelligence and computer vision collectively join together to analyze the big data obtained from predicted models. The role of AI in the agri-based food industry helps the stakeholders to access and monitor the supply chain. The phenomenon of applying AI and computer vision in the food industry would improve the entire operations. This research paper tries to provide an assisting model for farmers in food-processing and agriculture through the state-of-the-art method. Several concepts related to sustainability in food processing have been estimated through machine learning, and the deep learning model as a worldwide concept. The demand for the usage of AI and computer vision in the Ag-TECH industry has increased which impacts sustainable food production to feed the future. Certain implications have been suggested for real-time monitoring of the farming process, politics behind sustainable food production, and investment which is the main game-player in the present situation. The 4th Industrial Revolution [IR-4.0] was ushered in by the deployment of computer vision and AI in the food business, with computer vision robotics playing a crucial role in ensuring sustainable food production.

Keywords

Sustainability, supply chain, Artificial Intelligence, Computer Vision, IR-4.0.

Introduction

Artificial intelligence (AI) systems have piqued the interest of academics and practitioners in the last 20 years. To begin with, various people have attempted to define AI. Some authors define AI as a "machine's" ability to interpret the inputs offered by the environment in a "smart" fashion or to better interpret the external factors through a flexible setup (Kakani, 2020, Sun Q, 2019). AI denotes a new approach to create and handle knowledge in a well-rethought marketing strategy (Di Vaio, 2020, Nicholas, 2019), such as the link between sustainability and innovation (Kumar, 2019). In greater depth, innovation looks to be a commercial power. Indeed, breakthrough technology can enable the implementation of business strategies that address the UN vision 2030.

As a result, an increasing number of businesses are developing AI-based agri-food products capable of tackling many challenges while also conserving important resources by minimizing damage to the environment. Business models that address ethical and sustainable concerns are required for the implementation of AI technologies in the management process. As a result, these business models provide a comparative benefit for businesses without causing harm to the environment or community; as a result, the business models could be described as sustainable, and therefore are referred to as "sustainable business models" (SBMs) (Azadbakht, 2017, Barroca MJ, 2017).

The desire for new ways to reach and service people while maintaining prices low has prompted the application of AI to improve customer happiness, supply chain management, product quality, and lower costs in the food business, as well as other industry sectors.

Novel food manufacturing and industrial processing procedures have been made possible thanks to contemporary food sector developments (Babu 2019, Dr.Senthil Kumar, 2021). Various sorts of food have been in demand for the past 5 decades, including some unusual types like healthy ingredients, which have proven to be a key to a healthy lifestyle (Ventures DB, 2017). To meet market demand and produce quickly, the food industry developed a limited number of food processing procedures. Modern agricultural and food production technology was employed and might be considered inventive pioneers in the modernization of the food sector, before being supplanted by manufacturing facilities and smart machines (Rezek, 2021). Will these developments be able to feed the world's rapidly rising population while avoiding the inevitable? It looks to be conceivable, given the growth in supply and proportional increase in technological achievements (Ganesh, 2019, T. Muthuramalingam, 2019, Babu, 2021). During the previous century, the advent of 4IR technologies like computer image robots and AI has resulted in a huge radical shift in marketing tactics and investments (Dr. A. Senthil Kumar, 2020, B.K. Patle 2019). This cutting-edge technology could be a useful tool in meeting future needs for a secure food supply.

2. Artificial Intelligence is Divided into the Following Fields

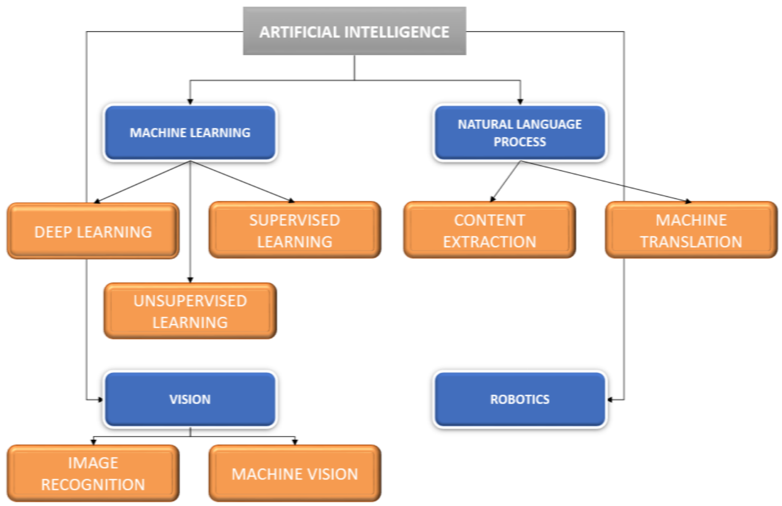

Figure 1 Artificial intelligence fields

The following are the most important of them:

Machine Learning (ML)

It is a key study of statistical and algorithm frameworks used by computer networks to efficiently complete activities without using explicit commands, instead of relying on inference and patterns (Lele U, 2017). To recognize a simple item including an orange or an apple, for instance. The goal is achieved not by directly stating the specifics and coding it, but by displaying several alternative photographs of it to a youngster and thus allowing the computer to design the measures to identify it like an orange or an apple (Dr. Qaysar Salih Mahdi, 2021). Figure 1 depicts the domains in which AI is used in the food processing industry.

Natural Language Processing (NLP)

NLP is a term that refers to software's autonomous processing of natural languages, such as text and speech. It's a branch of computer science that studies how to program computers to handle and evaluate massive amounts of raw language processing (Nabavi-Pelesaraei, 2021).

Vision

It's a branch of science that allows machines to see (Dr. Qaysar Salih Mahdi, 2021). Machine vision uses digital signal processing, camera, and to gather and analog-to-digital conversion to analyze visual data. It aims to automate actions that can be performed by visual perception (Kumar, 2021).

Robotics

It is a branch of science and engineering concerned with the building, design, management, and use of robotics, and also the control, visual perception, and data processing provided by computer systems. These techniques are being used to create machines that can take the place of people and mimic their actions (Kaab A, 2019). Robots are frequently used to undertake activities that are hard or inconsistent for people to complete.

Autonomous Vehicles

This vehicle is also known as a robot automobile or a self-driving car. It's a vehicle that can recognize its environment and move with little or no assistance from humans (Vilkhu K, 2008).

Artificial Intelligence uses in the Food Business

Selecting Raw Produce

One of the most critical difficulties that food production plants face is the uncertainty of feedstock supplies. In food processing factories, manual sorting is utilized to filter and segregate vegetables, leading to lower efficiency and greater prices (Marr B, 2017). AI, which utilizes a combination of scanners, cameras, and machine learning to enable more effective food sorting, can help food production companies gain significant productivity in food classification (Nosratabadi 2020). Time-consuming operations for sorting local produce, for instance, can be reduced by combining AI with sensor-based visual sorting techniques, resulting in improved yields, better quality, and less trash (Marr B, 2017). AI is being used to better adapt robots to manage a variety of item forms while lowering waste and costs (Kakani, 202). Figure 2 depicts the potato sorting device.

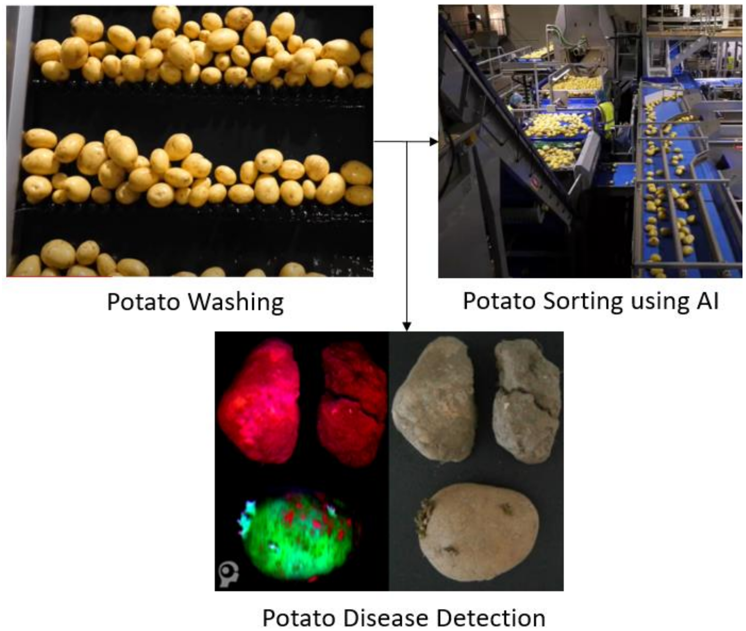

Figure 2 Sorting system for potatoes [16]

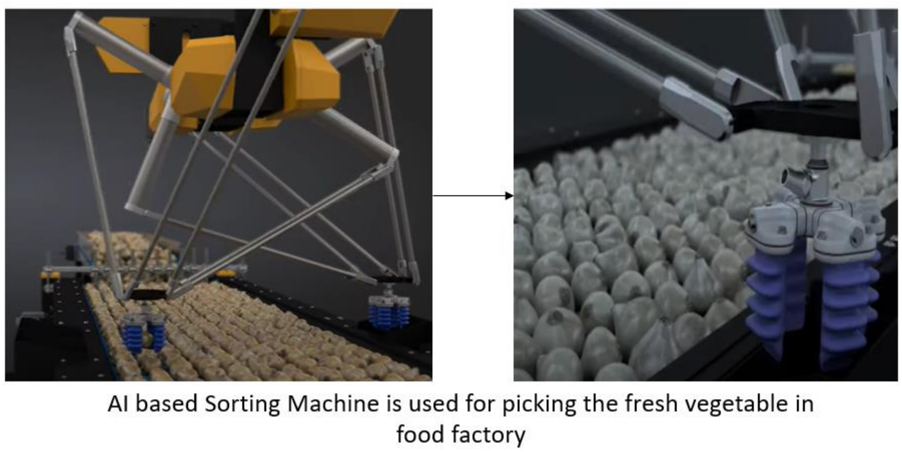

Figure 3 Sorting machine using artificial intelligence

Efficient Supply Chain Management

Supply chain control is a vital obligation for all food companies, given the growing demand for transparency. The food firm uses food safety tracking and analyzing products at every level of the supply chain to ensure conformity with consumer and industry requirements to develop supply chains. To handle pricing and supplies, more precise forecasting is needed (Jayashankar P, 2020). AI-based picture recognition solutions allow for more effective and effective product sourcing. AI also aids in the effective and efficient monitoring of products from producer to consumer, increasing consumer trust (Rawat RM, 2021). The AI-based Sorting device for vegetation is shown in Figure. 3.

Observance of Food Safety

AI-enabled sensors are used in food establishments to ensure that food employees follow safety rules. Figure 4 illustrates how face recognition and object identification technologies are used to determine if workers are practicing good personal hygiene as required by the Food Safety Act. The screen images are retrieved for evaluation and can be repaired in real-time if a violation is identified (Tsakanikas P, 2020). This method is more than 89 percent effective.

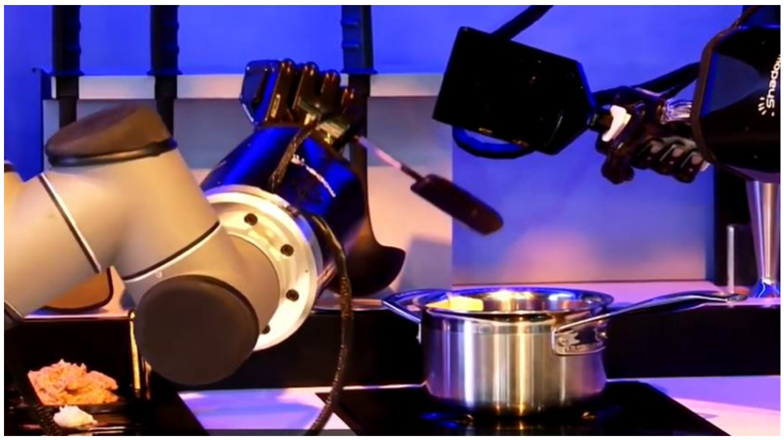

Figure 4 AI enabled camera in a food facility

Equipment for Food Processing Cleaning

Existing cleaning methods are programmed to clean gadgets at predetermined periods. This minimizes human involvement, minimizing the likelihood of food-borne viral cross-infection. This technology, on the other hand, is designed for worst-case situations and functions in the dark. Using AI-enabled technology (SOCIP), which uses infrared waves and optical fluorescence scanning to evaluate food waste and microbiological material in a piece of equipment and then improve the removal procedure (Tsakanikas P, 2020). As a result, there is a reduction in the amount of energy, time, and water used. (Garton K 2020). The washing time has been reduced by half.

Anticipating Consumer Preferences

Food manufacturers employ artificial intelligence-based solutions to predict and analyze their target customers' flavor choices, as well as anticipate their reactions to novel flavors. Food makers will benefit from Artificial Intelligence-based data analytics in designing new food items that are tightly linked with consumer preferences and tastes. In 2017, the Kellogg Company introduced AI-enabled software that assists customers in deciding which granola to use from a list of 50 components to create a personalized product

(Kuo TC, 2018). The AI gives suggestions for what items to use in your granola and tells you whether or not your items will work well together. Individuals aren't the only ones who can benefit from artificial intelligence when making tiny amounts of granola. The feedback mechanism created by the general information from flavor profiles, data on what choices people make, and what combos people re-order refines what flavors people truly like. This data source will most likely be highly beneficial to the parent firm when selecting what new items to offer in its much bigger brands.

New Product Development

AI technology uses deep learning and statistical analytics to evaluate consumer taste preferences and estimate how well they will react to novel flavors. Companies can segment the data into demographic groups to help them build new products that appeal to their particular audience's preferences (Bottani E, 2019). These might be used by manufacturers to anticipate which products would be successful before they reach the stores. Coca-Cola has installed self-service soft drink machines in several restaurants and other locations, allowing customers to mix and match their drinks. Customers may theoretically make hundreds of unique cocktails using this self-service equipment simply varying the base drinks (Ganesh, 2019, Viswanathan M, 2020, Mohammed, 2020, Dr. Idris Hadi Salih, 2020). Dozens of extra drink stations, each dispensing a variety of beverages daily, generated a massive number of customer preference information, which Coca-Cola is using ai to analyze. CHERRY SPRITE was the very first item to emerge from this data since its artificial intelligence predicted that consumers would generate a considerable quantity of cherry-flavored Sprite on their own and it would sell well.

Artificial Intelligence Front-End or Consumer Apps

1. Recommendation Systems

AI-based dietary research and recommendation engines can help consumers make informed choices about what to consume and what not to eat by employing algorithms that learn about the user's food demands and behavior (Ganesh, 2020, Suganthi K, 2020. Ganesh, 2019).

2. Chatbots and Applications

By utilizing AI-based Virtual Associates, food establishments can ensure that customers do not have to wait endlessly before submitting queries or modifying orders. The process has been simplified, which enhances the customer experience (Ganesh 2019, Qaysar Salih Mahdi, 2021, Ellappan Mohan, 2020).

3. Self-Ordering AI-based Kiosks

As seen in figure 5, self-ordering devices driven by artificial intelligence can help customers have a better service by reducing wait times and eliminating the need to queue for checkout. Using embedded card scanners, such computers can take customer orders and enable them to process transactions without the intervention of a human (Ganesh, 2021).

Figure 5 McDonald's Self Ordering Kiosk [give label]

4. Robots are getting some attention in restaurants, enhancing the speed and efficiency of food manufacturing while also decreasing the time it requires to deliver meals.

Robots in Hotel for welcoming

Robots for Serving Food in hotel

Figure 6 Robots serving

4.0 IR – Driven Agriculture or Food Industry

Computer Vision and AI Driven Food Industry

As an outcome of the current set of achievements in the AI sector, scientists and experts predict that AI will evolve into key applications fueling many organizations by 2020. The main cause for this is the rapid growth of digital information, which is expected to reach 44 trillion gigabytes per year by 2020. The 4.0 IR is on its approach through novel approaches to solve existing challenges in numerous fields, thanks to this huge data and trainable AI companies. The advent of industrial machines and equipment to build constructions ushered in the Industrial Revolution (IR). With the invention of the radio, electricity, and airplanes, the 2.0 IR began (Nicholas, 2019). The industry did not encounter a serious setback till the early 1970s when electronics and the internet ushered in the 3.0 IR by transforming the face of the globe through globalization and connection. Thanks to recent breakthroughs in computer vision, data analytics, and AI, the 4.0 IR may be witnessed in every field of production. The food industry was one of the businesses that have recently seen a significant impact from AI on its procedures, tools, and equipment. Crop farming, growth, processing, and production methods have all changed as a result of the introduction of AI-driven procedures and equipment into farming and the food processing industry. Computers may now do more than just show food photos; they can also identify and reveal calorie info about that item. Taking things a step further, IBM's AI Watson became the first AI chef in 2016 by proposing new and inventive meals only by glancing at the components. IBM's Watson silenced renowned chefs with its key capability of displaying variations in a dish with similar components. deep learning and machine learning are AI techniques that have made it possible to process photos using a computer's vision. Till 2012, image processing and computer vision were fields that processed images and allowed computers to comprehend the contents of the image, allowing them to make judgments. With the introduction of deep learning and machine learning, image processing has been able to expand its capabilities beyond its previous boundaries, reaching the pinnacle of technical innovation in tasks like detection, object tracking. Data, photos, movies, linguistic sequences, and so on. DNN was shown to produce superior results in terms of functionality in 2014, which drew attention to deeper systems and learning methodologies. Several benchmarks containing massive amounts of data for testing and training were created, eventually leading to a major contest to assess the performance of DNN on these datasets.

Food Manufacturing Techniques based on Artificial Intelligence

The analysis of information on cuisine and food items prompted researchers to look into the topic of food through AI lenses. In 2015, machines were clever enough to detect food from photographs provided, and in late 2016, MIT's AI was capable to estimate the contents and nutritive benefits of food demonstrated it. This innovation took only a few weeks to reach the general community as a mobile app. These AI solutions assist the food sector in effectively promoting its items to the market via global food rising tactics and marketing. Food manufacturing becomes more adaptable with equipment that can differentiate between fundamental problems like oranges and apples and more sophisticated duties like low saturated fats versus high unsaturated fats. Figure.7 A shows the food control methods used at “Stemmer Imaging” for different applications, whereas Figure 7 B shows the food tracking methods used at “Stemmer Imaging” for different applications. 7 B shows how LeNet architecture is used to apply deep learning to food categorization.

Figure 7 Computer vision and AI driven food industry (A) harvesting, picking, quality control and sorting using vision algorithms, and (B) LeNet deep learning architecture for food classification

Potential Prospective and Global Investments

Expanding demographics have a huge impact on things like government programs and worldwide operations. The most pressing problem about this topic is balancing food production and consumption in developing nations with growing populations. Private and governments investors are working to introduce AI and image processing innovations into industries like food agriculture and industry to solve specific issues and maintain productivity. The moderate increase in technological advancement lays the groundwork for the country's better financial status, with this component as a foundation.

Countries like China and India, in particular, are implementing government programs to increase food supply efficiency by utilizing technology like deep learning and information analysis. Google and Microsoft, for example, are donating their technologies to these nations and assisting in the formation of world economic sustainability. For instance, Microsoft and the Indian government's ICRISAT collaborated to implement Microsoft Cortana Smart Suite for agricultural information gathering and analysis using deep learning techniques. The Indian government set up trial sites in thirteen districts to learn about soil analysis labs, smart water systems, and IMOD techniques to promote farmers via public-private partnerships and state expenditures.

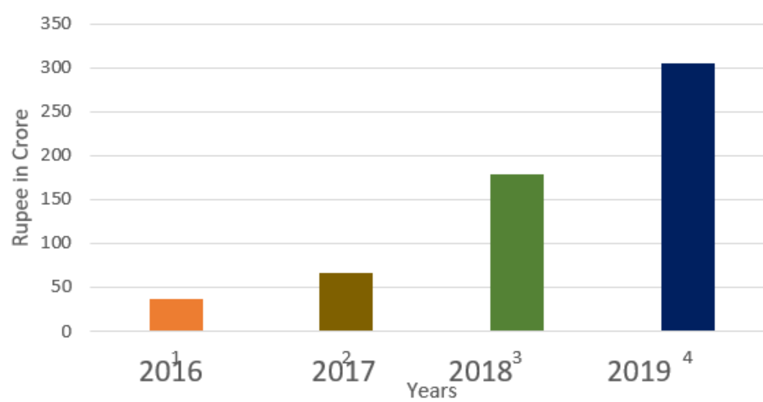

Figure 8 AgTech investment increased in recent years

Many private companies are working to apply AI and image processing technology to a task-specific agriculture benefit. In 2015 alone, the AgTech industry saw record-breaking spending of over 13 billion US dollars (Figure. 8), prompting numerous analysts around the world to predict AgTech as a significant movable component as a result of the 4IR.

To boost yields and achieve the objective of a stable food supply by 2050, AgTech entrepreneurs are turning to task-specific AI and image solutions. AgTech startups including ceres imaging, sky squirrel innovations, and blue river approaches use computer vision techniques in the form of photo collection, spectrum signal processing, and robotics. Sensor data may be a useful tool for analyzing farm characteristics, and companies like sencrop, centaur analytics, and spensa solutions are using it to spot irregularities in agricultural output and energy supply. Startups like cibo, trace genomics, myagdata, agrible, agrilyst, and benson hill biosystems, have used advances like plant statistical analysis and pa to improve production and ensure sustainable food production. Startups like aero farms, cropx aquaspy, alesca life, farm note, hydroponic information systems, connecterra, vibrant farms, and innovative animal prognostics are using data analytics and image processing methodologies to record, analyze, prototype, and anticipate factors that can enhance yields in poultry and next farms for greenhouse environment power guided by smart irrigation. Tables 1 show a complete list of AgTech startups that use AI and image processing technology.

Table 1 Next-generation farms and animal information among the AgTech startups

Technology	Entry	Usage
Forth Coming Generation farms	Aero-farms	Growing Fresh herbs, leafy greens, without soil and sunlight
Upcoming Agtech Farms	Bright-farms	Greenhouse control farms
Animal Data	Farm-note	Herbs management system
Animal Husbandry data	Early Animal disease diagnosis	Precise animal onsite and care disease detection

Conclusions

The use of 4.0 industrial revolution innovations like ai and computer vision in farming and the food business is discussed in this study. The current review, in particular, offers a thorough comprehension of computer vision and intelligence methods that are applied to a variety of agricultural apps, including food preparation, agriculture-based apps, agriculture, plant statistical analysis, smart water management, and next-generation agriculture. The research also focuses on the fundamental principle of using efficient 4IR technologies to ensure that humanity has enough food by 2050 while staying ecologically friendly. The importance of the AgriTech industry and advances based on AI and vision capabilities were investigated using use-cases and appropriate information. The agricultural food businesses that use computer vision and AI have been thoroughly researched and classed according to their many applications. Aside from food and agriculture-related firms, this article mentions a few others, including next-generation farmland and animal information.

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