INTELLIGENT FOOD PROCESSING INDUSTRY TECHNIQUES USING ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

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Abstract :The food processing and handling industry is a crucial sector that employs a significant portion of the global workforce. However, due to the involvement of humans, this industry faces challenges in maintaining an efficient demand-supply chain and ensuring food safety. To address these issues, industrial automation based on artificial intelligence (AI), machine learning (ML), and deep learning (DL) algorithms can be implemented. AI-based systems can optimize food production and delivery processes, enhance operational efficiency, and reduce human error. This article explores the various AI applications in the food industry that can lead to significant cost savings and resource utilization by improving sales prediction, quality control, packaging, shelf life, menu planning, and supply chain transparency. Furthermore, the future of the food industry lies in intelligent farming, robotic farming, and drones, which can be made possible through the integration of AI and ML

Keywords: Food Processing,Machine Learning, Deep Learning, Artificial Intelligence

1. INTRODUCTION

It is common knowledge that food, or ration, is a human need. It can be described as the best result of farming because it is made by giving out the various foods made by farmers. Products produced by the food industry are essential to the growth of any nation [1]. Additionally, it has a significant impact on the growth of the global economy as well as the economy of the nation. As a result, the food industry's products must be of high quality and distributed appropriately to ensure their safety. New technologies like artificial intelligence (AI) have been successful in achieving the desired goals over the past few decades [2]. As a result, AI-based smart agriculture and the advanced food industry must be investigated. These methods meet social requirements and deliver high-quality goods on time. The food industry can produce a large number of food products in a short amount of time using these cutting-edge technologies, which will exponentially boost the company's economy [2].

Nearly every area of technology makes extensive use of autonomous systems or AI-based systems. It enables the world to computerize the food industry, transform food industry products, and effectively optimize problems [3]. The food industry can examine and ensure that the most favorable conditions, such as seed selection, crop monitoring, temperature monitoring, and watering, can be improved through the use of a computerized system [4,5]. However, the application of AI is not limited to these specific areas. It can also be useful for food preparation, storage, and delivery. Robots and intelligent drones, for example, are intelligent devices that have the potential to significantly reduce packaging costs. Additionally, it will assist in the delivery of the food items, completion of the task in hazardous conditions, and supply of very high-quality products [6–8]. The significant jobs of simulated intelligence in food businesses can be comprehensively ordered into two classes: Food quality management and food security management are two others. The region under each class is given in Figure 1. By keeping each part of artificial intelligence in the food business, this study gives a writing investigation of AI and simulated intelligence in the food business.

The remainder of the manuscript is organized as follows: AI in the food processing industry, followed by smart farming. The significance of data analysis in the food industry is then addressed; Then, ML in the restaurant industry is talked about. According to the sanitation concern, computer-based intelligence is additionally significant; hence, the following segment will portray the computer based intelligence in sanitation. Last but not least, the scope of AI and machine learning in the food industry in the future is discussed. At last, the finish of the composition is included in the last segment.

2. LITERATURE SURVEY

Soil monitoring, robotic cropping, and predictive analysis are all important applications of AI in the food industry [9–11]. The following section provides a description ofThe most recent applications of AI in the food industry.

2.1. Soil Observation

In the ongoing situation, food enterprises are thinking about the advantages of man-made intelligence based frameworks. Computer vision and deep learning algorithms play a significant role in the AI-based system and are used to examine the sequence of information or data received by AI-based agents to track the development of crop and soil health [10, 12–22]. The computerized systems are used to provide customers with insight into the strengths and weaknesses of their soil. The development of the developed system was primarily motivated by the need to identify faulty crops and the likely method for healthy crop development.

In the new situation for Soil Checking (SM), when a rancher presents an example of their homestead soil to the observing body, a short time later, the client will get a nitty gritty outline of their field soil contents. An appropriate decision has been made regarding bacteria, fungi, and the broad microbial progression following the drawn results.

The Internet of Things (IoT) is a new technology that has advanced to the new era of advancement. Decisions about crop and soil monitoring are heavily influenced by the Internet of Things [16]. SM with IoT is the use of man-made intelligence that upholds ranchers and food ventures to exploit their economy, lessen the possibilities of affliction, and advance purposes of accessible resources. These use sensors to measure the temperature of the soil, the amount of nitrogen, phosphorus, and potassium (NPK) in the soil, the level of moisture, the amount of water in the soil, the potential in the soil, the amount of photosynthetic radiation in the soil, and the level of oxygen in the soil [17]. The col¬lected information from the different sensors are again sent to the server farm point or the cloud for a legitimate choice with the goal that sufficient activity can be taken convenient. The visualization of the received data as an outcome of the analysis aids in resource utilization. In order to determine the behavior of the system, it is necessary to determine the trends in the soil and adapt one's actions to the circumstances in order to maximize crop yield and produce high-quality goods [16, 17]. The horticulture based IoT is called shrewd farming. The IoT-based food industry is known as the savvy food industry.

Soil Observation, weather forecasting, and crop monitoring are the only components of IoT-based agriculture. Weather and irrigation are well-known to be crucial components of IoT-based agriculture. The elucidations on smart agriculture are also accompanied by an elegant atmosphere, such as clean air and a well-maintained irrigation system.

Numerous studies [13–20] in the literature on smart farming discovered that by utilizing these cutting-edge tools, resources can be optimized and income maximized. Likewise, there are some particular

regions, for example, pot and hemp, soybeans, potato, al-monds, cherries, apples, and grapes yielding promising creation by utilizing brilliant cultivating.

2.2.Robocrop

The food industry is also making use of cutting-edge tools based on technology in order to boost production. Robocrop is one of the tools developed by various research groups [18]. It is a robotic system based on AI that improves yielding by maximizing utility and uniformity. It conducts line up crop devices precisely and at a high rate. The food business item growth forward of the framework is observed by a high-goal and exact framework. A high-performance workstation processes the captured image to maximize the attention paid to green band pixels associated with the crop line. An outstanding typical crop center-line tracking is achieved [19] thanks to the extensive area captured by the input devices and numerous processing lines. It compares the resulting image to the crop line area of a real gridiron pattern. After that, a hydraulic shift is used to align the instruments in the row using the information that was obtained. The system is very healthy thanks to the pattern-based feature, and the background choice prevents infestations. Because of the multiple sensors and cameras, it performs better and produces more.

Outstanding research in the field of harvesting robots has been carried out by a number of authors [23–25] in the field of robocropping or agricultural automation, which has significantly increased productivity in recent decades. The advancement of these systems as well as their additional advantages, including increased productivity and a decrease in the number of employees, contributed to their popularity. The dual-arm harvesting robot, which has two arms arranged in an optimal way, was described in an earlier article [23]. Based on SVM, this dual-arm robot is suitable for fruit harvesting. Robotic weeding makes it easier to automatically and effectively control weeds near or within crop rows in agricultural automation. A picture processing¬based framework [24] was intended for recognizing crop plants at different development levels for mechanical weeding control. Adaptive Robotic Chassis (ARC), a particular system developed for strawberry flowers, is included in the list of existing systems [25]. Strawberry flowers are first taken in by the system's installed camera and then processed. The robot finally achieves the desired coordinate and performs significant actions.

The input image features completely determine the robocrop's performance. Excellent results are obtained when the input image contains more dominant features. In each example of an information picture, the harvest should introduce more growth than the wildflower and the yield greenery ought to be close to the mean of the RGB variety band. A common robocrop framework comprises of a robocrop console aspect, a water powered based shaft, a three-point linkage outline, a superior quality camera, different kinds of speed sensors, an ADC connector, etc. One example of robocrop picking fruits is depicted in Figure 3 [19].

2.3. Prescient Examination

In order to track and anticipate a variety of environmental influences on crop yield, such as changes in the weather, learning models are developed. ML algorithms play a very important role in this. ML calculations in relationship with the satellites explore crop manageability, foresee the climate, and survey homesteads to be aware of the presence of irritations and illnesses. The model does a very good job of providing high-quality, frequently updated data or information. In addition, the company regularly has access to more than one billion stacks of agronomic data, indicating that it has a high degree of confidence in the data it provides to its clients. Predictive analysis relies heavily on historical data, such as precipitation, wind speed, solar radiation, and temperature. The got investigation accounts a significant job for sufficient booking and harvest choice for specific horticultural land [20].

FarmShots is an artificial intelligence startup based in Raleigh, North Carolina, that focuses on analyzing agricultural data derived from satellite and drone imagery. The company's primary focus is on finding pests, diseases, and low plant nutrition in farms [21]. The company restricted John Deere customers' free access to its products until June 2017 in April 2017. With this coordinated effort, it is a lot of clear that John Deere is showing more interest in going into horticultural tech opportunity.

3. METHODOLOGY

The Food Processing Industry and Artificial Intelligence:

Pattern recognition, data science, deep learning, machine learning, and robotics are just a few of the artificial intelligence fields that will be discussed in this section and how they are used in the food processing industry. In addition to food processing, AI plays a crucial role in managing the entire processing unit task in the food handling industry. Figure 4 depicts significant applications derived from the food processing and handling sector.

3.1. Packaging and sorting of products

One of the tedious and time-consuming processes for manufacturing units in the food processing industry is the proper ordering and packaging of food products. Subsequently, such a dreary errand can be dealt with by man-made intelligence based frameworks so the opportunity of blunder is limited, and the creation pace of the in¬dustry is quickly expanded. Due to the varying sizes, colors, and shapes of fruits and vegetables, it is difficult to create AI-based systems. For de¬veloping a simulated intelligence based arranging and bundling framework, a lot of information is required so the framework is appropriately prepared and plays out the errand in a productive way [26, 27]. For the same purpose, various research groups developed distinct systems. TOMRA is one of them, and it does the sorting job quickly and effectively. It increased production quickly and accurately by 90%. The automated system currently handles the majority of product sorting and packaging tasks. Industries gained advantages like a faster production rate, higher yields of high quality, and lower labor costs by utilizing such systems.

High-resolution cameras, systems based on laser technology, systems based on X-rays, and IR spectroscopy are some of the tools and methods that make up the AI-based intelligent decision-making systems. At the input channel, these technologies and tools are used to analyze each and every aspect of food products like fruits and vegetables. Products can only be distinguished between good and bad products using conventional systems. By utilizing TOMRA, it has been seen that the disconnecting and requesting issue can be worked on by 5-10% on account of potatoes just [28, 29]. A Japanese company that employs a TensorFlow ML-based system dealt with the same kind of issue and also achieved remarkable results and gained significant benefits for their assembly unit. Other food processing industries also benefited greatly from this system. Also, every association found that the man-made intelligence based framework works all the more unequivocally. The exhibition accomplished for potatoes empowers the extension of artificial intelligence based frameworks for others moreover.

The AI-based systems have also taken care of these guidelines. An AI-based system was initially developed by the KanKan and Shanghai municipal health agency in collaboration. The first AI-based system is intended to provide anonymous quantities with facial and object recognition. The system is used to keep an eye on people who don't follow the rules [30]. In the case of anything matches, then, at that point, it very well may be settled continuously right away. The designed system produces excellent outcomes; As a result, it was planned to make the system available to more and more organizations.

3.3. Customer Decision-Making System

It has been discovered that AI is not only assisting customers in selecting novel essences but also assisting the food processing industries in developing various flavor combinations [31]. In 2018, Kellog introduced Bear-Naked-Custom, which allows customers to customize their own granola using more than 50 ingredients. It keeps track of every person's tastes, customer preferences, and a great deal of other information while taking care of them. When introducing a new product to the market, this kind of information is crucial [31, 32]. Consequently, computer based intelligence again assumed a decent part in creating dynamic frameworks for clients

3.4. Maintenance and cleaning of the equipment

In food pro¬cessing enterprises, legitimate cleaning and support of handling devices are a lot of fundamental. AI-based systems are well-suited to handle this kind of job [33]. In order to carry out the operation, a variety of sensors and cameras are used. One Whitwell and Martec product has the muscular weakness that it can be reduced to only 50%, allowing for greater efficiency in a shorter amount of time. Martec is currently attempting to defend its AI-based cleaning place model. For this strategy, Martec incorporates optical fluorescence and ultrasonic sensing imaging techniques into the AI system development process [34]. It measures the machine's remaining amount of food and microbial debris. The system will enter stand.

3.5 New Product

Introducing New Products It takes a lot of effort to launch new products for any production unit. Particularly in the food industry, it is entirely dependent on the consumer's interests. As a result, new product launches benefit from the data gathered by various customer decision-making systems. The gathered data is handled by the ML-based module and afterward takes the legitimate choice for the item [2, 35]. Questions like "what customers are exactly looking for" have been answered by employing an ML-based strategy. Almost all food processing and packaging industries are currently expanding and introducing new products into the market with the help of artificial intelligence. Beforehand, this work has been helped out through a contextual investigation or review. As a result, the system has a very low success rate. Now that everything has changed, AI and machine learning are often used for these kinds of tasks.

3.6. Management of the supply-demand chain.

However long food ventures are more stressed over food handling strategies, they are expected to emerge more clearly in regards to the pathway of food items in the store network framework. AI is used to monitor each stage of the process [1]. It handles everything, from controlling prices to managing inventory. It likewise deals with guaging and moni¬toring the pathway of assets from where they are developed to where clients gather it. Simulated intelligence based Orchestra Retail gives the office to book trans¬portation, charging, and stock administration [36]. Additionally, it maintains discipline and prevents the accumulation of numerous commodities that result in exhausted material.

4. ANALYSES OF DATA IN THE FOOD INDUSTRY

The food industry is brimming with numerous food establishments and well-known brands. Because of the developing rivalry, this industry is losing its fascination for laying out another business [37]. Using technology, particularly data science, is the only way to stay ahead of the competition in the food industry.

4.1. Customer contentment.

The founder of Gobble, Ooshma Garg, suggested that the food industry could be compared to a technology company. For the rest of the world, it was a controversial assertion, but there is some truth to it [37, 38]. Information science has turned into an essential in current innovation driven enterprises for hoisting and moving their different strategic policies. Gobble is a great illustration of an industry that completely depends on data science to predict supply and demand. It offers its clients with ten-minute supper units and has more than large number of standard clients with various menu decisions. It gathers the information like purchasing history, client conduct, and criticism and food inclination of various time spans to guarantee the preparation to satisfy the needs [39]. Gobble is an example of a company that uses artificial intelligence in the food industry on a demand-driven basis and can undoubtedly serve as a model for other businesses in their sector.

4.2. Presenting New Recipes By combining the ingredients, a

A single recipe can be cooked in many different ways. Additionally, the fact that these ingredients can be cooked in a variety of other ways opens up a world of culinary possibilities. Numerous recipes can be found online, each of which contains a substantial dataset that enables novices as well as experts to investigate various culinary components. The researchers are able to distinguish between the various cuisines' differences and similarities [40]. For instance, East-Asian and Southern-European cuisines avoid using ingredients that contain the same flavor compounds as those found in North American and Western European cuisines.

In conclusion, technologists are able to determine which food components taste well and identify a cuisine that is popular in some provinces. Because of this fundamental comprehension, algorithms based on artificial intelligence are also able to recommend chefs various combinations of ingredients that will undoubtedly expand the menu and boost food industry profits.

5. AI IN FOOD SAFETY

Artificial Intelligence and Food Safety Robots are widely accepted in the food processing industry due to their sterility. This element is a tremendous figure diminishing the quantity of staple related infections. The Sanitation Modernization Act (FSMA) has drafted stricter sterile necessities, which is relevant for complete store network frameworks. Cereals, spices, and other food products that don't need refrigeration and are most susceptible to contamination are to blame. Previously, such food items were liberated from tainting, however presently, the situation is totally different. AI-based systems certainly have the potential to assist in resolving issues of this kind. Like humans, they are immune to illness transmission. An AI-based system, on the other hand, requires little to no upkeep [2, 49]. As per the report distributed by Technavio, the execution of robots in food handling enterprises will lift up by 30% and furthermore satisfy the public authority's requests. Additionally, it is anticipated that some brand-new, ground-breaking innovations utilizing artificial intelligence in food safety procedures will soon become widely known.

Electric Noses and Sequencing of the Next Generation Next-generation sequencing (NGS) and electric noses (ENs) are the two food industry innovations that hold the greatest promise. The DNA method is quickly overtaken by NGS in the food security area. The development of AI-based automated systems and workflows expedited and improved the formulation of laboratory trials and data acquisition. The NGS is able to quickly and effectively identify dangerous tendencies. It can also stop epidemics of infections before they cause a lot of people to get sick. In environments used for fabrication, ENs serve primarily as a substitute for a single muzzle. A few sensors are set that can exactly distinguish a variety of scents. These sensors simply detect the smell in the immediate area, and the data they collect are sent to a data center, where machine learning algorithms can access the data [42, 43]. As per the choice made by the ML-based framework, a caution signal is moved to the assembling units. As a result, EN may represent the foreseeable future of food product safety.

Management of food waste The report distributed by the Branch of Horticulture, USA, pronounces that, "In the US, food squander is assessed at somewhere in the range of 30 and 40% of the food supply. Based on estimates from the USDA's Economic Research Service that retail and consumer food losses were 31%, this corresponded to approximately $161 billion and 133 billion pounds of food in 2010. The magnitude of this waste has far-reaching effects on society.

By the year 2030, McKinsey claims that AI will be able to eliminate a significant amount of food waste and resolve such issues. Launching additional regenerative leisure farming practices can produce such surprising statistics [44]. It demonstrates that humans are not effectively utilizing the resources at their disposal. Smarter farming techniques can take the place of conventional farming practices. In this, different sensors are sent and gather the data. ML algorithms are used to process the collected data before making the right choices. By utilizing these, ranchers can settle on choices the quickest and exact. The following are some AI-based suggestions for reducing food waste:

(i) While a few clarifications look at the development of the organic products, others height out what microorganisms can help foods grown from the ground improvement excluding the interest of fake composts.

(ii) Manufacturers can obtain ground examination purge by compensating artificial intelligence, preserving a significant amount of capital.

iii) Each step in the farm-based food supply chain management is managed and examined using computer vision technology; then, there will be a rapid decrease in food waste.

(iv) Food tracking systems based on artificial intelligence will allow us to sell food before it goes to waste. With this, more people and farmers can connect to purchase food products.

In reality, there are too many obstacles to overcome to be communicated by a single system body or organization. The food industry as a whole needs to change. In order to construct an effective system that significantly impacts the entire world, a comprehensive group of associates must collaborate.

6. CONCLUSIONS

This study provided precise facts about the advantages of AI for food businesses and how it can be implemented. The food industry currently employs the fundamental level of artificial intelligence. Because of its capacity to improve hygiene, food safety, and the waste management system, the role of AI is becoming more and more important every day. Later on, man-made intelligence will change the food handling industry since it has such a lot of potential to create sensible and better efficiency for clients and representatives. By reducing human errors in manufacturing and, to a lesser extent, the amount of leftover product, the use of AI and machine learning in food production and restaurant businesses is already elevating the industry. It makes it possible to reduce shipping and packing costs, improve customer satisfaction, provide faster services, voice search, and make orders that are more tailored to the customer. These business benefits can likewise be benefited for enormous food manufacturing plants which will acquire an undeniable advantage the long run.

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