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ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN FOOD AND AGRICULTURE INDUSTRY

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ABSTRACT

Because human labor is essential from the cultivation of raw materials to the final packing of finished products, the food processing and handling industry is the largest employer globally and in the manufacturing sector as a whole. Human intervention has led to the collapse of global food systems. poor demand-supply forecasting, leading to food insecurity. Industrial automation on a large scale is the only solution for the food industry's problems. A.I., M.L., and DL are the pillars upon which automation rests (various machine learning and artificial intelligence techniques). With an AI-based system in place, food production and distribution are simplified and improved. In this piece, we'll investigate how artificial intelligence (AI) is being utilized to displace human labor in the food business in order to cut costs, increase production, and minimize waste. AI and data science working together might boost productivity in the food service business, which includes restaurants, cafes, online meal delivery chains, hotels, and more. Using a more open and transparent supply chain management

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system, which can be enabled by AI, food packaging may be vastly improved, leading to an increase in the food's shelf life, an improvement in its safety, and the creation of new menu alternatives.

keywords:- Artificial intelligence, machine learning, food safety, food production, food distribution.

INTRODUCTION

A 60-110% increase in global food production is anticipated to be necessary to meet the needs of 9-10 billion people in 2050 [1, 2]. As a result, the future of agriculture is crucial to guaranteeing food security and eliminating hunger for the world's rising population. Food safety problems, such as bovine spongiform encephalopathy and dioxin in chicken [3], highlight the need for a robust traceability system to assure high standards of production across the food supply chain. Water scarcity due to climate change has increased the need of responsible water use and conservation. The existing paradigm of increasing agricultural output must give way to a new approach aimed at ensuring agricultural sustainability for these reasons. Farmers and other stakeholders may benefit from being able to foresee potential issues and implement solutions more quickly if they adopt sustainable agricultural practices, notably ones that make use of digital technology such the Internet of Things, artificial intelligence, and cloud computing. Humans have an inherent need for food, and equitable distribution of the many products produced by farmers is the pinnacle of agricultural success, both of which need rationing. The food items of every nation are essential to its economic growth [1]. It is of the greatest importance that food items be of the highest quality and delivered in a safe way since the food business is vital to the health of economies throughout the world. Artificial intelligence (AI) and other modern technological breakthroughs have achieved their goals during the last few decades. That's why it's crucial to study how artificial intelligence might be used creatively in fields like farming and food production. With the aid of these cutting-edge machinery, the food sector can rapidly mass-produce a wide variety of food goods, improving efficiency and profit [2]. This helps assure the timely supply of high-quality commodities and the provision of critical social services. AI-based technologies, often known as autonomous systems, have become the norm in the information technology industry. It facilitates the global optimization of issues, the automation of the food sector, and the modification of food items [3]. There may

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be many more potential applications for AI. Food production, storage, and preparation might all benefit from its utilization. Artificially intelligent robots and drones are two further examples of cutting-edge technology that could be useful in lowering packing costs. Helps transport consumables, functions well in potentially dangerous environments, and supplies premium goods [6-8]. Artificial intelligence (AI) has two main applications in the food industry: ensuring food safety and improving product quality. Figure 1 displays the proportion of covered area for each category.

After providing this context, the study dives into an examination of AI's role in the food processing industry. We will then go on to examine how data analysis and machine learning can help hotels succeed. What follows is a discussion of the potential uses of AI in the field of food safety. In conclusion, we talk about the future of the food industry and the role that AI and ML may play in it.

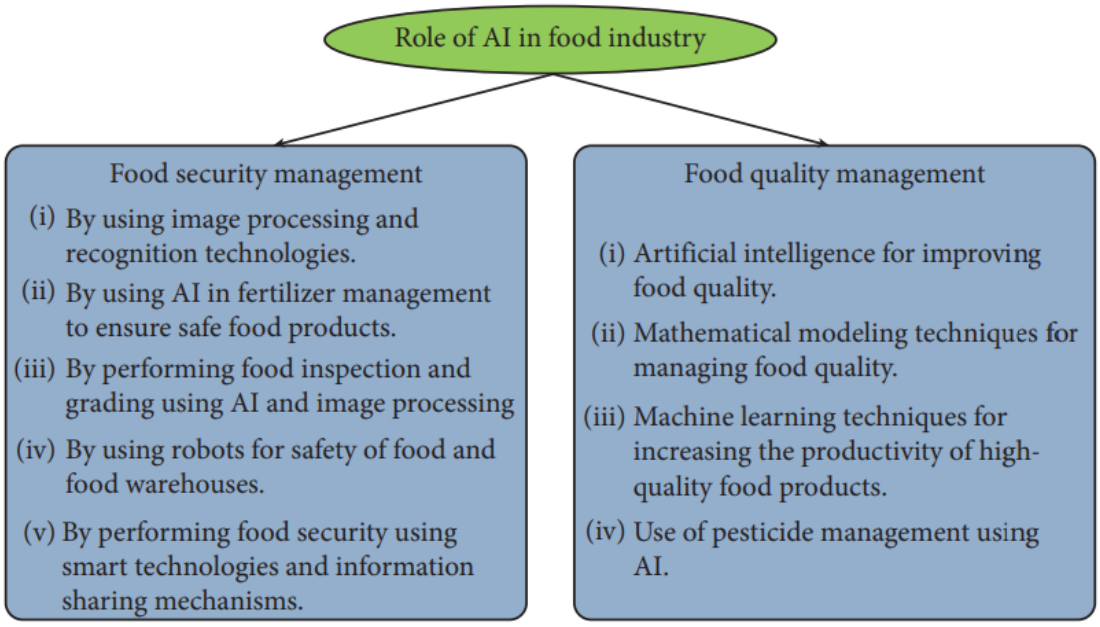

Figure 1 Role of AI in food industry

MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE APPROACH

Artificial intelligence (AI) is the attempt to create intelligent and capable machines using only electronic equipment, primarily computers, robots, and other digital apparatus. [4]. Natural

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language processing (NLP) can be used to understand human speech in real time, and voice recognition and expert systems can be used to mimic human decision making. AI is based on three fundamental cognitive abilities: the ability to understand (collect data and generate algorithms to transform it into valuable information), reason (choose the best course of action to achieve a goal), and correct its own mistakes[6]. Using the labeled data in combination with the known input and desired output variables, a reliable prediction model may be developed. Several distinct types of algorithms may be grouped together as supervised learning techniques. Unsupervised learning use unlabeled datasets and techniques such as ANNs, clustering, evolutionary algorithms, and deep learning to discover patterns without being told what input and output variables to look for. [8]. Businesses may already begin using AI thanks to recent advancements in the field. More and more farmers are turning to artificial intelligence (AI) technologies to increase agricultural yields while decreasing water and energy use. Machine learning and deep neural networks are used to analyze the performance, classify the data, and foresee any future problems or occurrences in these programs. Researchers are evaluating abiotic and biotic variables [4, 9] with the use of remote sensing and sensors for application in agricultural and animal management. The agri-food industry and allied businesses stand to gain greatly from the widespread adoption and implementation of AI, both of which have already contributed to more efficient methods of producing, harvesting, and selling agricultural commodities. Finally, owing to AI, farmers may always have access to the most recent weather predictions, enhancing their capacity for education, preparation, and the timely, By applying the chemical just where it is required, rather than all over the field, these methods might be utilized to significantly cut down on herbicide usage.

SMART FARMING

Soil monitoring, robotic cropping, and predictive analysis are just a few of the ways in which artificial intelligence is already making strides in the food production sector [9, 11]. Current AI trends in the food business are shown in Figure 2. In the next sections, we will detail each application.

Soil Monitoring

Recently, the topic of using technology based on artificial intelligence (AI) in the food business has come up for discussion. Computer vision and deep-learning algorithms play a significant

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role in continuously monitoring crop and soil condition in an AI-based system [10, 12]. Thanks to advances in electronic technology, information regarding the soil's benefits and drawbacks may be made readily available to customers. Monitoring crop health and identifying the most efficient techniques of fostering unhealthy crop growth were the primary motivations for developing this system. Thanks to Soil Monitoring, today's farmers may get an in-depth report on the soil's composition after mailing in a sample from their land (SM). This knowledge might help us develop more effective strategies to combat bacteria, fungi, and other organisms throughout the globe.

In 1980, Japanese farmers became the first in the world to use a drone equipped with artificial intelligence to protect their harvest from vermin. Aerial monitoring equipment and artificial intelligence are now widely used in agriculture [15] to maintain tabs on crop health. Maximizing profits while decreasing costs is E's primary objective. After considering your alternatives, you may direct the drone to fly directly to your intended location. Afterward, the pc vision system will snap a few photos for analysis. "Internet of things" describes the next step in the evolution of today's technology (IoT). Internet-of-Things-collected data is crucial to agricultural and soil monitoring decisions [16]. SM with IoT is an AI application that, when used to the agricultural and food production sectors, has the potential to increase profits, reduce the occurrence of illness, and optimize output. These [17] may be used to monitor a wide range of soil conditions, including temperature, nitrogen, phosphorus, and potassium (NPK) concentrations, water content, electrical potential, photosynthetic rate, and oxygen content. Information gathered by numerous sensors is sent back to a hub, such the cloud, where it may be processed and used to make the best choice and take the appropriate action at the right moment. The resulting visual representation of the data from the study may be used to optimize the allocation of scarce resources. If you want to maximize crop yields and final product quality, you must accurately identify the system's behavior [16, 17]. In contrast to "smart food," which refers to the use of IoT in the restaurant business, "smart agriculture" discusses the use of IoT in agricultural. Monitoring soil conditions, making accurate weather predictions, and keeping tabs on crops are the backbone of modern farming thanks to the Internet of Things.

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Artificial Intelligence In Food Processing Industry

A second crucial area where AI is vital is manufacturing, where it manages the complete processing unit work. Figure displays a few examples of useful applications from the food processing and handling sector.

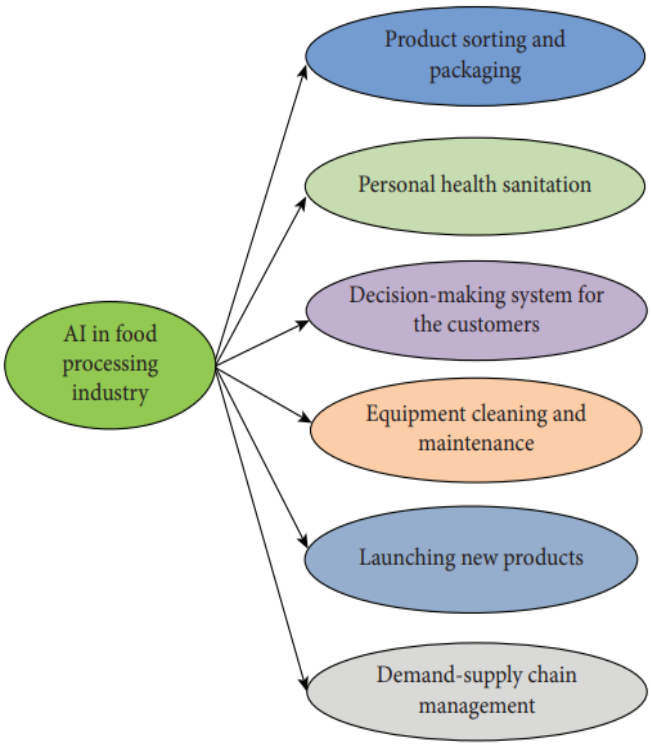

Figure 2 Important examples adapted from the food-processing industry.

One of the most time-consuming and labor-intensive procedures in food processing enterprises is the correct arrangement and packing of food items. Because of the high potential for human mistake and the high potential for increased productivity, AI-based solutions may be employed to manage such a time-consuming task. The diversity in size, color, and form seen in vegetables and fruits presents unique challenges to the development of AI-based systems. Artificial intelligence (AI) requires a large amount of data to learn how to efficiently sort and package goods [16, 17]. Several separate research facilities independently devised notably diverse strategies for accomplishing the same goal. TOMRA has become an industry leader in the sorting industry. Efficiency and effectiveness skyrocketed. These days, automated machines accomplish the majority of the packing and sorting. Industries that adopted these advances saw

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gains in productivity, improved product quality, and reduced labor costs. Important applications in the food business are shown in Figure 2. Numerous equipment and techniques, such as high-resolution cameras, systems based on laser technology, X-ray systems, and infrared spectroscopy, are used by intelligent decision-making systems. Input-channel techniques and technologies are used to perform comprehensive checks on produce and other food products. Traditional methods can only tell the difference between high-quality and low-quality goods by visually inspecting them. It has been shown that TOMRA may reduce the difficulty of detaching and sorting potatoes by 5-10% [18, 19]. A comparable problem was resolved with similarly excellent outcomes and huge advantages for an assembly unit at a Japanese company using a solution based on TensorFlow ML. All three companies agreed that the AI-based solution was the most accurate one. Because of the positive results of the potato experiment, scientists may want to apply AI to other challenges. It may be expanded to suit the growing demands of the food processing sector.

Personal Health Sanitation

After learning of its effectiveness in other nations, the food processing unit cleanliness guideline has been implemented in many nations. The use of AI has allowed for solutions to this problem that are fully compliant with all applicable regulations. The KanKan and the Shanghai health bureau first collaborated to develop an AI-based solution. Using AI, the first system for unattended object and human identification was created as early as [20]. A quick solution might be found if a match is found. Due to the proven effectiveness of the brand-new technology, more and more businesses will use it.

Analysis of Food Industry Data

The food business is filled with household names, both in terms of brands and eateries. Competition is high, which discourages would-be entrepreneurs from entering the industry [17]. When it comes to maintaining a competitive edge, businesses in the food sector must adopt cutting-edge technological strategies, including data science. Information analysis in the food sector is discussed with some examples in Figure 3.

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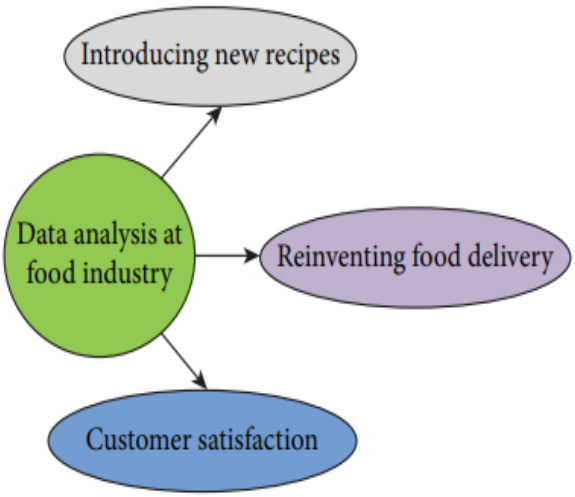

Figure 3 Data analysis at food industry

Customer Satisfaction.

Ooshma Garg, the business's namesake, has argued for categorizing the food industry like a software company. This assertion was contentious from the outside, although it is based on evidence [17, 18]. Data science is crucial in today's tech-driven economy for streamlining and directing the many types of organizational operations that exist. One industry that makes heavy use of data analytics for demand and supply planning is the pharmaceutical industry. The company's 10-minute meal kits and other products consistently attract the attention of tens of thousands of customers. It keeps track of clients' purchases, activities, views, and gastronomic preferences over extended periods of time [19] so that it may better serve their demands. Perhaps other businesses in the food industry who are considering using AI to meet rising consumer expectations might learn from Gobble's approach.

Reinventing Food Delivery

Swiggy, Zomato, and Uber-eat are just a few of the many meal delivery businesses that retain meticulous information on their clients' order histories and favored foods. It is possible that those working in the food industry will use data science and AI to streamline operations and save costs without lowering standards or slowing down service [21]. Some well-established businesses might gain a lot by applying AI to their field. While its potential is undeniable, its

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implementation in the food sector is still in its infancy, and greater optimization on the part of food firms is required to give better service to clients during the ordering and delivery of food.

CONCLUSION

This research effectively displays the many advantageous outcomes and future applications of AI in the food industry. Artificial intelligence is only getting started in the food sector. Three sectors where artificial intelligence is having an increasingly obvious influence include sanitation, food safety, and garbage collection. Artificial intelligence (AI) has the ability to totally alter the food processing business by fostering fair and healthy productivity for customers and workers. Artificial intelligence and machine learning are also helping the food industry and restaurants reduce wasteful food and beverage product disposal. It allows for more customization, faster response times, voice-activated searches, and more efficient packaging and shipping at a lower cost. All sizes of food processing businesses might stand to benefit from these opportunities.

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