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A Brief Review of Artificial Intelligence Robotic in Food Industry

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Abstract

Artificial Intelligent Robotic (AI Robotic) is the formal term for an 'intelligent induced' robot that can operate with vision (eye) to detect a product defect, or a control operating system to assist robot to differentiate good and reject product during production. A number of cutting-edge manufacturing automation technologies have been developed, including automatic inspection, autonomous robots, additive manufacturing, ubiquitous manufacturing, cloud manufacturing, and cyber-physical systems. Intelligent and automation technologies for worker assistance have been considered feasible. As knowledge-driven industries develop in terms of artificial intelligence and robotic automation, and to upgrade the existing and next generation of workforce, higher and further education is needed to advance a better understanding of robotic automation in manufacturers who face endless challenges such as labor shortages, high turnover labor force, product innovation, quality matters, and many others. This paper provides a general view of food supply chain challenges when faced with labor issue, environmental disaster and production problems. AI Robotic application would be a good source of problem solving in food manufacturing, food processing and food handling process.

Keywords: Artificial Intelligent, Robotic, AI Robotic, Food Industry

1. Introduction

In the coming future food products and processes must be environmentally friendly, with reuse, remanufacturing, and recycling built in for products nearing the end of their useful lives. Factory automation is a well-known solution to these issues in modern manufacturing. Future product development entails meeting society's ever-changing needs while also opening up new frontiers. Customization is a key differentiator in value added manufacturing, delivering viable products as well as new services and localized functionalities [1]. The food industry is a critical segment that requires increased attention, particularly in food handling, to improve food sanitation and safety. Autonomous food

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production could be the crucial factor to encounter rising food demand. Over the next five years, the global food automation industry is expected to double in value, reaching 2.5 billion dollars by 2022 [2]. Because of the popularity of ready-to-eat foods as consumers adapt to fast-paced working lifestyles, the Asia-Pacific market is a major driver in this region of the world [2].

Since the coronavirus was discovered in Wuhan in December 2019, scientists, economists, and many business experts have agreed that saving lives is linked to economic performance in China. Countries that have successfully reduced their Covid-19 cases have been more effective in reopening their economies. Most countries will see little or no growth in 2020, whereas China will grow for the 33rd year in a row [3]. Manufacturing companies face numerous challenges and must regularly transform to endure competition. Process innovation, which is the starter of new processes or new methods of doing things, is only way to innovate [4]. Meanwhile, the COVID-19 pandemic has caused havoc in factories around the world. Due to the depressed economy, number of manufacturers were forced to close or operate on a reduced scale. In recent years, a number of cutting-edge manufacturing automation technologies have been developed, including automatic inspection, autonomous robots, additive manufacturing, ubiquitous manufacturing, cloud manufacturing, and cyber-physical systems. Intelligent and automation technologies for worker assistance have been considered feasible. Some of these cutting-edge automation technologies are intended to promote factory cooperation by sharing manufacturing resources, which is difficult in the midst of the COVID-19 outbreak; smart and automation technology applications to assist employees have been considered feasible [5].

According to the International Monetary Fund, the COVID-19 pandemic will affect roughly 90% of the world's population. According to this forecast, global GDP will contract by at least 4.9 % in 2020[6]. To steer market progress and ensure that we proceed toward a future that is sustainable, equitable, and inclusive, that provides universal opportunity, and that does not obstruct progress, we need clear and effective incentives. Individuals without job security have been proven to react badly in their work environments, eventually behaving in a deviant manner that is harmful to the corporation's aims [6]. The food supply system has evolved into a highly complex industry when we harvest food from farm up to eatery outlet. Industrial robots are being integrated into every stage of the food chain in order to increase productivity so as to harvest a higher quality product that meet customer expectations. In the food manufacturing industry, robots are used in many sectors of the food supply chain. The food industry ranks fourth in terms of automatability even its adoption was slow from the start [7].

Robots are the best fit in the food industry where speed, consistency and high level of repetition are required. In terms of efficiency and accuracy, robots typically outperform humans. The most recent robots have intelligent vision, multitasking, and verbal command understanding [8]. Customers' flavour profiles can be created with the help of robots, and new recipes can be created based on data acquired from customers over time. It improves a person's overall well-being at work, especially in physically demanding jobs like heavy load lifting and repetitive fruit and vegetable cutting. It has the potential to reduce muscular skeletal disorders that are frequently associated with the food industry [9]. Products which need fragile grip such as tofu, sushi, and potato chips, will need a robotic hand complete with fluid fingers and a fluid pressure monitoring-based grasping method (pneumatic system). The jamming principle will be used to develop a universal gripper concept. It is capable of handling a wide range of objects, such as a shock absorber coil, screw driver, bottle caps, and plastic tubing, among others [10].

The automation and robotics concept can be extremely beneficial in a variety of ways, including increasing packaging speed while avoiding spending the majority of time on wrapping processes. Although technology can aid in the food processing sector by eradicating manual labour and increasing general progress rates, it is currently underachieving in many nations, particularly India. Hygienic handling in meat and dairy industries is vital but due to human interruption in process handling, these products are prone to contamination [11]. The food business is one of the most reliant on quality control, as the quality of at least one ingredient can have an unswerving influence on the quality of the final product. In their visual inspection system, Kewpie Corporation (a large Japanese food producer) uses Google's TensorFlow machine learning libraries to automatically detect irregularities in diced potatoes. Fujitsu has also created a system for detecting potential faults in the production process by combining non-destructive testing (NDT) with image processing and Deep Learning algorithms to produce a diagnostic in minutes [12]. According to the International Federation of Robotics, 373,000 industrial robots were sold worldwide in 2019. By 2020, there will be 2.7 million industrial robots in factories worldwide. The efficient use of industrial robots, as well as their dependability and availability, are critical, and this has sparked a surge in interest in robot optimisation and new implementations in a variety of fields, particularly non-manufacturing and non-traditional applications [13].

Hence, this paper will provide a brief review on AI Robotic diverse application to solve food production from labour shortage, productivity improvement and food-borne contamination. This paper will provide a study reference for potential AI Robotic buyer to consider the investment of AI robotic automation in their food manufacturing facility, whereas for the academia and related agency will have a broader knowledge on AI robotic application and implementation.

2. Covid-19 Outbreak Affects Food Production

The COVID-19 pandemic is a worldwide disaster that has exaggerated many facets of people's lives. The majority of the impacted countries implemented lockdowns, business closures, cleanliness controls, social isolation, school and university closures, and travel restrictions. The COVID-19 pandemic is a global problem that affects many parts of people's lives. In order to stop the spread of COVID-19, most afflicted countries implemented lockdowns, cleanliness rules, social isolation, education institution closures, or mobility tracking. These policies are expected to have an immediate and long-term impact on people's working lives [14].

Taking the current situation into account, the current concern is the fear of a coronavirus (COVID-19) pandemic, which is spreading through human contact. As a result, everyone is under physical and psychological stress. This epidemic has had a substantial influence on the food processing industries. Aside from that, many contagious diseases pass from an infected individual to a food product, causing serious health problems for consumers. The most essential and critical issue in the processing industry is hygiene, and robotics can assist in maintaining a nice and clean, germ-free environment [15].

According to the International Monetary Fund, the COVID-19 epidemic will harm nearly 90% of the world's economy. According to this projection, the global economy would decrease by at least 4.9 percent in 2020. In some low- and middle-income nations, the shocks are exacerbated by pre-existing budgetary vulnerabilities, volatility in commodity prices and exchange rates, a drop in remittances, and a contraction in tourism [6]. The supply chain network demonstrated poor resistance to this pandemic, with roughly 35% of manufacturers reporting supply chain network failure as a result of the worldwide coronavirus pandemic. More than 230 million people in the EU-27 and the United Kingdom are directly or indirectly affected by the closure of non-essential shops, cancellation of numerous events, travel restrictions, and reduction in production [15].

According to the World Economic Outlook, global growth will begin to decline dramatically in 2020. The worst economic downturn since the Great Depression took place. The virus, according to the IMF's managing director, is affecting 170 countries worldwide, including Malaysia, which is experiencing a Covid-19 pandemic. Malaysia's exports drop 25.5 % year on year in May 2020, the most since May 2009, while imports fell 30.4 %. Due to warehouse closures, vendors, for example, are unable to pick up their cargo at the port, and some ports are reducing manpower, exacerbating the cargo backlog. This causes indirect disruptions in the supply chain, most notably in the logistics system for critical products such as food and medicine [16].

Hence, robotic automation has been a new trend in food industry such as robotic in processing process to maintain a nice and clean, germ-free environment. COVID-19 also brings a challenge to supply chain interruption in tourism, agricultural and fishery in term of human handling operation, which open a good opportunity for robotic automation [8].

3. Applications of AI Robotics in Food Industry

3.1. Overview of AI robotic

Artificially intelligent robots, which mix AI and normal automation robots, are one of the many varieties of robots available. AI algorithms and models are used by such robots to perform more than just a series of motions and extend their autonomy—but more on that later. AI robotics are in high demand today, and they can be used in a variety of ways, either on their own or in conjunction with other technology.

A warehousing robot could navigate the warehouse using a path-finding algorithm. When a drone's battery is about to die, it may use autonomous navigation to return home. A self-driving car may employ a variety of AI systems to detect and avoid potential road hazards. Artificially intelligent robots come in a variation of shapes and sizes [17].

The function clearly distinguishes AI robotics from conventional robotics. Conventional robotics follow rigorous criteria to automate jobs and free up people to focus on intelligence-intensive tasks. AI robotic, on the other hand, is all about making technology as human as possible [18].

While robotics is concerned with automation, it also incorporates other disciplines such as mechanical engineering, computer science, and, in many cases, AI. Machine learning techniques enable AI-driven robots to fulfil functions and tasks required of them autonomously. Intelligent automation applications, in which robotics provides the body and AI provides the brain, are a better description of AI robotics. Other technologies used in industrial automation, AI, and robotics include computer vision and natural language processing. As a result, AI robotics can perform a variety of tasks without the need for human intervention, such as detecting and placing an article on a warehouse floor [19].

A growing number of businesses are creating AI-based agri-food system solutions that can handle a variety of problems while also saving important resources and lessening environmental harm. In order to use AI in process management, business models that take sustainability and social responsibility into account must be created. These business strategies give companies a competitive edge while also having no negative effects on society or the environment, making them what are known as sustainable business strategies [20].

3.2. AI Robotic for Betterment of Food Handling

Customers' flavor profiles can be created with the help of robots, and new recipes can be created based on data acquired from customers over time. It improves a person's overall well-being at work, especially when performing physically demanding tasks like heavy lifting and repetitive fruit and vegetable cutting. It has the possible to decrease muscular skeletal problems, which are often linked to the food business [8].

Smart agriculture powered by AI and the innovative food industry Such methods address social needs while also delivering high-quality products on time. It also helps with food processing, storage, and distribution. Intelligent devices like robotics and intelligent drones can also assist in lowering packaging costs. It will also help with food delivery, task completion in hazardous environments, and the provision of high-quality products [21].

Agriculture, horticulture, livestock farming, input suppliers, and the food processing industry are also developing autonomous robots. In addition to making the food production system more environmentally friendly, autonomous robots and other digital agricultural technologies have the potential to increase the effectiveness of producing and delivering food to a growing population [22].

3.3. AI Robotic in Fruit Industry

One of the aspects influencing consumer impression is the appearance of fresh fruits and vegetables. In response to consumer demands, machine vision is a new tool for evaluating and improving the quality of product look. It makes it possible to assess product qualities including freshness, lack of flexibility, and ripeness, which are essential for a customer's initial perception of a product. It is possible to employ this technology for activities including product packaging, form evaluation, fault finding, and quality evaluation. Some researchers looked into the prospect of using fluorescence imaging with hyperspectral linear scans to spot pollution on the surface of apples and developed a simple multidimensional algorithm [23]. Machine vision technology can be used to rapidly and reliably identify any damaged or contaminated apples and remove them from a production line [23]. A robotic apple picker with four to twelve robotic arms, half of which operate on each side, is being developed by FFRobotics, an Israeli business launched in 2014. Before collecting apples on either side using a three-fingered gripper that can mechanically grab and twist the fruit from a limb, the robot approaches the row of apple trees and sets stabilizers. The fruit's size, color, and maturity are evaluated using sophisticated imaging equipment and algorithms. The robot automatically moves to the following area of the orchard after selecting the portion [24]. A real-time machine vision framework for robots harvesting dates in an orchard environment was designed using deep learning. The framework contained three models for classifying date fruit bunches according to type, level of maturity, and harvesting technique. When completing classification problems, transfer learning with fine-tuning was applied [25].

3.4. AI Robotic in Agriculture

The agri-food industry is becoming more digital as a result of the threats that cause widespread contamination. Digital innovations like AI, big data, and robotics have the potential to help businesses and farmers in a variety of ways. AI can be applied to precision agriculture, weather forecasting, irrigation optimization, and soil quality assessment, for instance. Big data can be used to trace supply chains, monitor agricultural growth, and offer insights for wiser decision-making [26]. Crop monitoring, planting, and other chores can be handled by robotics. These innovations can boost productivity, cut waste, and raise the standard and security of food production [26].

Agricultural AI includes both AI software and AI robots. AI software frequently offers information, recommendations, and data. The first type of AI entails collecting a large amount of data from the farm, the environment, the machinery, and so on, and then combining AI techniques (machine learning, deep learning, and reinforcement learning) to forecast and advise farmers on when to plant, harvest, and sell their crops, the health and behavior patterns of their livestock, and image recognition to detect plant disease. On the other hand, AI robotics harvest fruits and vegetables independently on farms [27].

3.5. AI Robotic in Poultry Industry

The emphasis was on Agricultural Intelligent Automation Systems, which have a lot of promise for use in agricultural production and processing, especially chicken production. Object recognition, product quality evaluation, plant and animal growth and development monitoring, yield prediction, and machine guidance have all been prioritized. Agricultural robots are classified according to their role (monitor, harvester, or both). One of the most prominent issues in robotics applications has been the construction of robots for specialized agricultural jobs. Poultry farming practices include monitoring environmental conditions and chicken health, egg picking, and encouraging bird movement [28].

The current poultry production system will be replaced by a highly intelligent, automated, and data-driven system. Rich data sets covering every stage of broiler and breeder production, transportation, and processing will be kept in cloud servers, and AI will process the input data continuously and evolve over time to make consistent judgements. The majority of everyday chores are handled by versatile robots, such as eliminating mortality and monitoring flock behaviour to assure the birds' growth and welfare [29].

3.6. AI Robotic in Food Logistic

To increase overall sustainability, food logistics must lower carbon emissions and logistics costs. Automation is the employment of other automatic mechanized technologies such as a robot to complete certain duties. Any corporation using robotics and automation does so because it wants to cut costs, boost production, and speed up operations. Robotic and automated processes also offer more efficiency and a better working environment. In order to guarantee end-to-end tracking and traceability in the food supply chain, robotics and automation can be extremely important. Food products can be observed and tracked at every step of the supply chain, from farm to table, by employing sensors and other tracking technologies. The most major benefit of logistics robotics applications is the optimization of goods handling and transportation [30].

The rapid growth of intelligent control technology has influenced the logistics business, resulting in the deployment of novel concepts for autonomous indoor logistic robots. These robots move commodities and packages around warehouses and factories. A tremendous motivation exists to minimise the cost of these mobile robots and build flexible control methods. To achieve the flexibility and cost-effectiveness of the newly created mobile robot solution, new technology such as AI and machine vision are applied [31].

3.7. AI Robotic in Food Crop

As a result of improving living standards, technology and image processing (IP) improvements, and the growing relevance of food quality, the food industry is embracing new technologies. In contrast, the food business requires speedy and precise analysis procedures since population growth raises customer expectations and awareness.

Producers must push higher quality food and agricultural products in order to meet customers' sophisticated demands [23].

IoT-based Smart Agribots detect humidity, soil quality by analyzing the presence of vitamins and minerals, and can verify the quality of crops, among other things, to save time and free workers from inhumane working circumstances. These robots operate in three steps: the first is to retrieve the input data, the second is to process the input, and the third is to launch the output. These robots are typically used for autonomous harvesting, but they can also be used for other purposes [11].

Agriculture is in the midst of a massive transformation. To achieve supply chain traceability, it focuses on digital technologies, specifically AI and machine learning, the Internet of Things, Cloud, and Blockchain. Adoption of these technologies is an important step towards protecting consumers and improving agricultural production quality. One of the areas to be examined is the use of AI to the agri-food sector, which blends modern sensory technology with computer processing power. Machine learning and deep learning, computer vision, experienced systems, physical robots and software robots, natural language processing and generation are the most essential AI technologies for increasing agri-food quality and retail services [20].

Agriculture, horticulture, livestock farming, input suppliers, and the food processing industry are also developing autonomous robots. According to authoritative policy documents, AI robotics is one of the digital farming technologies that will aid in the resolution of a wide range of societal issues. Farmers may optimize crop output, reduce waste, and lessen the environmental effect of farming practices by utilizing digital farming technology such as autonomous robots, precision agriculture, and AI-based solutions [22].

4. Conclusion and Recommendation

Based on this review, AI robotic automation has a vast application and versatility in different food manufacturing industry, it helps to reduce food handling contamination and safety work space. Workers who are able to leverage on AI robotic will be able to improve on work performance in term of productivity and efficiency. Besides that, this study provides valuable information and some implications for AI robotic in future research. First, the study has management implications for companies readying to implement AI robotic automation in their facility. Also, some companies have tried to use it for commercial objectives, and it helps to continue to improve their AI robotic systems more efficiently. Finally, this study also has the significance on application and implementation of AI robotic in this industrial 4.0. That is because AI robotic is one of the categories of industrial 4.0. So it is a good precedence for betterment of Malaysia industrial growth. In short, the company can use this information to determine consumers' acceptance level of AI robotic and improve it.

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