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Application of Artificial Intelligence in Fruit Production: A Review

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Abstract

A data by UN FAO proclaims that the availability of land area for the crop cultivation will be 4% in 2050 with additional population of 2 billion to the existing global population. This context creates a strong pressure over agricultural production, where there will be more demand for food. The food production obtained from these traditional methods of cultivation which have been followed by farmers right now were not sufficient or may fail to feed this growing global population. Adaptation of new and latest technological solutions for the improvement of farming might be the only possible way to meet out the food requirement in future. While artificial intelligence (AI) proved to support all sectors of agriculture to boost the productivity and also helps to control uninvited natural condition. AI-supported solution makes the farmers to produce more with less in addition quality improvement in products. AI technology helps to achieve competitive advantage in market. In recent years AI powered systems aids the farmers in all process of fruit production such as in irrigation scheduling through smart irrigation systems, detection and diagnosis of pest and diseases, weed management, precise predictions, *etc*. Current review discussed the insights in artificial intelligence and its various applications in fruit production.

Key words: AI application, Artificial intelligence, Crop protection, Fruit harvest, Fruit yield prediction.

UN FAO (*Food and Agriculture Organization*) proclaims that the availability of land area for the crop cultivation will be 4% in 2050 with additional population of 2 billion to the existing global population. This context creates a strong pressure over agricultural production, where there will be more demand for food. The food production obtained from these traditional methods of cultivation which have been followed by farmers right now were not sufficient or may fail to feed this growing global population. Adaptation of new and latest technological solutions for the improvement of farming might be the only possible way to meet out the food requirement in future. While Artificial Intelligence (AI) proved to support all sectors of agriculture to boost the productivity and also helps to control uninvited natural condition. The solution is to create a shift in agriculture and to assist us to overcome the challenges in agriculture and its application. AI-supported solution makes the farmers to produce more with less in addition quality improvement in products. AI technology helps to achieve competitive advantage in market. In recent years AI powered systems aids the farmers in all process of fruit production such as in irrigation scheduling through smart irrigation systems, detection and diagnosis of pest and diseases, weed management, precise predictions, *etc*. AI technology not only improves the farming efficiency, it facilitate precise and accurate farming of fruit crops.

Artificial intelligence (AI)

The word ‘artificial’ in AI portray ‘non-biological’ and the word ‘intelligence’ denotes ‘ability to achieve complex tasks’. AI technology is developed based on the concept that a technology which think and perform complicated work similar to the performance of human brain (Jani *et al*. 2019; Parekh *et al*. 2020). Human brain remains as most complex organ which contains billions of neurons that are connected to each other in a neural network. Meanwhile, AI is a technology to develop human brain in digital format by employing various complex algorithms (Joseph *et al*. 2020). This technology execute the function of human brain in several way *viz.,* educating itself like humans, finding the reason and solution for problems and on critical decision making times act like human. On other word AI is machine with human brain.

AI is defining as the study of computer system and software which strive to be a model with artificial mind similar to human intelligence. It simulates the intelligent behaviour of human beings think and act (and in times to come, better than them), accomplish the thought process of human in all sensible tasks (Saxena *et al*. 2020). AI based technologies helps to govern the challenges in agriculture such as crop establishment and protection, soil nutrient and moisture sensing, improvement of yield with good quality. It aids in field management and enhance the field efficiency on the whole (Kim *et al*. 2008).

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Scope of AI in agriculture

The Internet of things (IoT) driven development

With IoT applications, it is possible to include computers in the field of agriculture. A massive volume of data are getting generating each day regarding weather pattern, soil report, rainfall pattern, recent research, pest attack, disease outbreak, etc. This solution of IOT will sense entire related data and impart deep insight to increase the crop yield. IoT system on partnership with Image processing system to observe plant growth and to gather information related environmental factors. Here, the temperature and relative humidity tends to be measured with the help of sensors (such as temperature sensor and humidity sensors) which are connected to the IoT network (Lakshmi and Gayathri, 2017).

Image-based insight generation

It generates alerts in real time to facilitate precision farming which is more focused area in today's agriculture and also helps in pest and disease detection, recognition of nutrient deficiency and more on. For example by detecting the real time plant diseases using images will help the farmers to act right. Automated system for the identification of plant diseases with the help of images of leaves in the image processing system can be achieved through Convolutional Neural Networks (Ferentinos, 2018). An automated system is generated to recognise various diseases of various crops *viz.,* banana, mango, jackfruit, lemon and beans with image segmentation technique (Singh and Misra, 2017).

Identification of crop maturity

Quality and further postharvest life of produce highly depends on the harvesting the produce at correct stage. As, most of the physiological changes are intangible, analysing the ripening pattern of produce under white light and UV-A light would help us to distinguish the produce with different level of maturity. This helps in accurate categorization of produce and ensure better quality and price. The ripening process of fruit can also be monitored through Artificial Neural Network that would reveal the most precise physiological state of the produce (Altaf *et al*. 2020).

Recognition of disease

Plant protection is the most important part in crop production. Identifying the diseases at their early emergence stage will help us to ensure quality of the produce and to reduce the cost of cultivation. This can be achieved by image sensing and analysis. The images of cropped surface areas divided into different sections such as background, diseased area and non-diseased area. From this area with infected section is cropped and sent to the laboratory for the identification of pest and to sense any nutritional deficiency. For instance, in banana a deep neural networks system is used to detect the leaf spot diseases such as sigatoka leaf spot and speckle leaf spot precisely without any confusion with the challenging environmental conditions such as, complex background, illumination, different resolution, size, pose and orientation of the image *etc*. (Amara *et al*. 2017).

Automation techniques in irrigation

Now a day's irrigation of crop is done on the basis of decision made by human on their own knowledge and experience. But this is an inadequate decision point of human on irrigation process. Thus, an automated irrigation system for watering the crop is required since water is the most important resources nowadays where the scarcity of water resource is another crisis. These automated irrigation system will be more accurate than the individual's own personal judgment and this system will also increase water, oxygen and production efficiency. As the AI trained machines work on the basis of historical weather pattern, soil quality and type of crops to be grown, it provides automated irrigation at optimum level and results in positive impact on overall yield (Dharmaraj and Vijayanand, 2018). Above all, the automated system helps to prevent the water wastage, decrease the cost and loss of work power in the field of irrigation. This system can be easily managed remotely with the mobile application as well (Aydin *et al*. 2021). Using Internet of Things (IoT) sensing system and with help of soil moisture sensor, an automated irrigation can be preformed in the orchard of peach where water is turn on and off as per the need of crop detected through sensors. (Long He, 2022) with this system ease of scheduling irrigation for the fruit orchards become easier for fruit growing farmers.

Application of AI in fruit production

The automation is essential key area of interest in case of precision farming. Artificial intelligence possesses various functional works in agriculture. The most important and few examples of AI application in production of fruit crops are given below.

Prediction through AI

Presently artificial intelligence systems were utilized for developing predictive models for many agriculture practices and monitoring of yield (Panda *et al*. 2010). Though the current methodologies focus on post-harvest yield prediction, it is preferable to focus on pre-harvest yield prediction methods for fruit crops. Most of the fruit growers estimate their yield by counting fruits during the early fruit drop. As the manual methods of yield predictions such as counting, calculating by weight of the produce *etc*., are time consuming and inaccurate, artificial intelligence powered models can be exploited. In case of cherry fruit, prediction of two most important disease-causing pathogens namely *Monilinia laxa* and *Coccomyces hiemalis* were done using data mining (Ilic *et al*. 2018). Gobasco (an artificial intelligence-based platform) offers locating, optimization and yield prediction for the agricultural produces.

Another interesting method of yield prediction as developed by the Robotics Vision lab of Northwest Nazarene University that estimates fruit yield by counting the blossoms (Braun *et al*. 2018). It was found that during the blossom period photosynthetic activity tends to increase, which positively correlates with the fruiting process. Hence the fruit yield can be estimated by counting the blossoms by using the correlation between the blossoms detected in an image with the actual number of fruits in the tree. This system of early yield prediction is successfully implanted in Pink Lady Apple cultivars (Braddock *et al*. 2019). In Kiwi, firmness of the fruit was measured by predicting N and Ca concentrations, including their ratio in fruit at the time of harvest using Artificial Neural Networks (Torkashvand *et al*. 2017).

AI in crop health monitor

The crop health monitoring is a critical factor to ensure productivity of crops. Early detection of crop infestation with pest, nutrient deficiencies and stress due to climate change are needed to mitigate the problems of low productivity. This can be achieved by means of high resolution weather data, remote sensing data, AI technologies and AI platform. All these provisions make crop monitoring process easy, accurate and provide additional insights to the farmers on time. Soilsens technology is a low cost smart soil monitoring system to help farmers who facing farming decisions predicament. Soilsens system consist of various sensors that includes soil moisture, soil temperature, ambient humidity and ambient temperature sensor to make a decision on optimum irrigation using mobile app in order to increase the water use efficiency. The plantix application is used to determine the potential defects and nutrient deficiencies in soil. The analysis is conducted by software algorithms which correlate particular foliage patterns with certain soil defects, plant pest and disease. This application also detects crop diseases and offers advice regarding respective treatment measures for the detected disease by the app. In banana, *Fusarium* wilt (the most common and serious diseases of banana) can be mass diagnosed early by using E-Nose integrated autonomous rover system which is fabricated with MOS sensors (Sanjay and Kalpana, 2017).

In case of examining the crop maturity in the fruit orchard, most of the time manual prediction leads to inaccurate decision. Hence precise monitoring equipment that is capable of rapid detection of produce quality is desirable, together with a low marketing cost. The E-Nose would be the potential tool in this regard, as it monitors the production of volatile organic compounds in the crop with specific situation. Thus indirectly monitor and evaluating the crop growth at real time (Voss *et al*. 2019).

AI in crop protection

Plant protection is crucial in crop production because of its complexity in understanding the cause and lagging tools for detection of specific infections as well for the prediction of condition that were favorable for infections. A cost-effective automated system comprising AI and machine vision are used to recognize, differentiate and geo-locate citrus psyllid (*Diaphornia citri*) in orchard of citrus (Partela *et al*. 2019). Utilizing deep learning models in image processing and recognition system is a latest technology to spot diseases of different crops through visible symptoms captured in précised manner. Several banana pest and disease are identifiable even by the persons who lack knowledge on symptoms produced due to infection of various pest and diseases of banana with the help of detection model developed using artificial intelligence with deep learning systems (Selvaraj *et al*. 2019).

A knowledge-based system for apple diseases helps the farmers to identify the symptoms and cause of various diseases and treats the disease whenever possible (Shawwa and Naser, 2019). Similarly, in pineapple a knowledge-based expert system for detection of various diseases and recommendation of disease management method for pineapple diseases (Shawwa and Naser, 2018). Likewise, in banana a knowledge based expert system was developed to manage banana diseases to have insights on to the diagnosis and treatment of various diseases in banana (Almadhoun and Naser, 2018). The most common postharvest disease of Golden Delicious apple was able to identify with aid of an electronic nose (E-Nose) technology during processing and packing of apples (Jia *et al*. 2019).

AI in harvesting of fruits

AI powered solution for ease of harvest lower the cost of man power utilize for harvest as well harvest the produce at right time. Mechanical vibration harvester is used to harvest walnut. This harvester comprises two mechanism namely clamping and exciting mechanism. Here mechanical force used to create vibration at definite frequency and amplitude which makes fruits fall off from branches and are collected on loading device (Yang, 2020). In other words, the vibration accelerated to weaken the binding force of fruits to branches which facilitates harvest of walnuts precisely (Rapur and Tiwari, 2018).

Future scope

Research in AI technology is still in progress and hence research on artificial intelligence is covering wide area. Till now precision in AI in agricultural sectors are lagging a hundred percent precision. This inaccuracy made will miss lead farmers to make decision. However, practical feasibility is more important which serve as the proof for success of the developed system. There are various future scopes for AI-driven sensors in agriculture. Agricultural scientists specifically, pomologists may focus more on these AI-driven sensors which helps to improve fruit production and productivity. Image processing and detection through AI system helps to protect crops from any kind of attacks and this helps farmers to control more uninvited condition. Until the technology reaches the farmers the developed technology never attains its true success. Hence, it is recommended to make the developed technology accessible to commercial fruit growers in wider scale through any TOT (Transfer of Technology) centers.

CONCLUSION

Artificial Intelligence (AI) a technology developed based on the concept that a technology which think and perform complicated work similar to the performance of human brain. This technology execute the function of human brain in various way like educating itself like humans, finding the reason and solution for problems and on critical decision making times act like human. On other word AI is machine with human brain. There are several evidences that AI is an efficient tool to improve farming efficiency. However, the application of AI in fruit yield predication, pest and disease recognition and fruit harvesting techniques are discussed detailed in this paper. Finally, AI can help humanity and also has efficiency to solve the problem of food requirement of future generation with limited resources irrespective of climate. Moreover, many researches on Artificial Intelligence are at primary stages whereas their precision level needs little more precise as well as their practical feasibility are under checked. Researchers should focus the problems of AI discussed in this paper and make the AI model to next level.

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